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COCONUT SHELLS AS AN INDUSTRIAL RAW MATERIAL

IV. COCONUT SHELL CHARCOAL: (A) COMMERCIAL

THE second article of this series[31] dealt with miscellaneous uses of coconut shells as such and with their value as fuel. The uses there considered were only of local importance. The present article is concerned with a commodity—Coconut Shell Charcoal—which, during the War of 1914-18, and again in the years immediately preceding the present war, acquired general commercial importance.

Charcoal is essentially a more or less impure form of carbon obtained from various animal or vegetable matter by ignition out of contact with air. Charcoal burning is a very ancient art; and the use of wood charcoal for smelting must date back to the earliest use of metals, which has been put back as far as 4000 B.C. The description of charcoal burning in Theophrastus' (370-285 B.C.) *Enquiry into Plants*[42] is supplemented by practical information which sometimes has a curiously modern ring: "Different kinds of charcoal are used for different purposes—thus in iron mines they use that which is made of sweet chestnut when the iron has already been smelted, and in silver mines they use charcoal of pine-wood—Smiths require charcoal of fir rather than oak; it is indeed not so strong, but it blows up better into a flame, as it is less apt to smoulder." "Worst of the woods mentioned is oak, since it contains most mineral matter."

Charcoal prepared from coconut shells does not appear to have come early into use in coconut-growing countries. Thus, although Robert Knox in the seventeenth century describes iron smelting as for long practised in Ceylon, he makes no specific mention of coconut shell charcoal. It appears likely moreover that wood charcoal rather than shell charcoal entered into the manufacture of gunpowder, described in 1818[43] as "of very ancient practice in the country" (Ceylon); the latter is indeed not very suitable for the purpose.

Bennett (1843)[19] and later authors (*e.g.*, Seeman, 1856),[44] mention the conversion of coconut shells into "lampblack, and charcoal; which latter, when pulverized, forms an excellent dentifrice". Lampblack, so referred to, is probably a preparation made by condensing the soot from burning shell, though Grisard and Vanden-Berghe (1889)[21] seem to suggest the use of ground shell charcoal in paints, and as late as 1919 a writer in the *Mysore Engineers' Association Bulletin*[45] used the charcoal from dry distillation of shells with linseed oil as a blackboard paint and said that the finely powdered "shell-coke" (as he called it) "may probably prove to be a good substitute for lampblack". What is nowadays described as lampblack is essentially the soot from an unobstructed hydrocarbon flame and has properties which could hardly be reproduced by powdered charcoal.

Regnaud (1856),[22] who evidently wrote more at first-hand than most of the nineteenth century authors quoted, notes the use of shell charcoal in the Maldives and elsewhere in metal working: "La coque du coco ... Transformée en charbon, elle devient précieuse pour le travail des forges, et ne le cède en rien a la houille entré les mains des Maldiviens et des habitants des ilots de la mer de l'Inde, qui sont sous la dépendance de Maurice." A cor-

respondent of the *Madras Mail* in 1886[46] stated that "charcoal of the coconut shell is specially used by native goldsmiths in melting gold and silver". In Ceylon, shell charcoal is still considerably used for such small-scale metal work, including precious metals and brass.

The desiccated coconut and machine-made coir industries developed in Ceylon from the end of last century; in mills devoted to these manufactures the large accumulations of shells were and are used as fuel (*cf.* ref. 47) and frequently converted into charcoal used for producer gas engines. There are also references to the use of shell charcoal in copra drying, and the manufacturers of the "Chula" copra drier were stated in 1914[48] to recommend this fuel; such use has not, within the writer's knowledge, ever been general.

The War of 1914-18 brought into use the product known as "activated carbon" as a means of defence against poisonous gases in warfare. Coconut (and other nut) shells give products particularly active for this purpose, and were developed considerably in the U.S.A. Brown and Merrill (1919)[49] state: "In 1918 the United States military authorities had an extensive organization for securing large quantities of this charcoal in the Philippines." Much of the work on research and manufacture at that time was secret and precise statistics of production do not seem to be available.

From 1933 fairly extensive exports of coconut shell charcoal were made from Ceylon; Tabel I shows the quantities exported in the years 1933-41 inclusive.

TABLE I

Exports of Coconut Shell Charcoal from Ceylon

Year	Amount tons	Value Rs.	Value per ton Rs.
1933	2,019	90,541	44·85
1934	6,234	350,996	56·30
1935	7,667	365,668	47·68
1936	6,751	377,137	55·86
1937	13,455	977,708	72·66
1938	10,997	823,781	74·91
1939	18,568	1,361 880	73·35
1940	14,967	758,739	50·69
1941	1,697	68,807	40·55

Table II shows the distribution of the Ceylon exports from 1936-39 inclusive.

TABLE II

Distribution of Coconut Shell Charcoal Exports from Ceylon (in Tons)

	1936	1937	1938	1939	Total 1936-39
U.K. ..	3,223	7,448	4,077	4 085	18 833
France ..	3,353	5,603	6,570	14,272	29,798
Holland	175	100	100	200	575
Italy ..	..	300	..	..	300
Roumania	..	..	250	..	250
Others ..	..	4	..	11	15
	6,751	13,455	10,997	18,568	49,771

In the same period there were some sporadic shipments from the Philippines, where, however, there were no official trade figures prior to 1939. In 1936-37 there seem to have been shipments of at least 1,000 tons to Italy and Germany and for the first six months of 1939 the Bureau of Customs issued the following figures.[50]

TABLE III

Exports of Coconut Shell Charcoal from the Philippines

(First 6 months, 1939)

	Tons	Value (Pesos)
Great Britain	139	10,242
France	225	5,827
Japan	15	194
	379	16,263

There was little development in Malaya, shipments being only recorded of 80 tons exported in 1940;[51] and whilst there was some apprehension in Ceylon of competition from the Netherlands East Indies in 1938, output from this source was apparently not large. Only comparatively small quantities were supplied from there to Japan, Germany, Denmark and France.[52]

In South India, shell charcoal has been made for service purposes, but particulars have not been released.

All of these exports were of crude charcoal; there has been so far no development of the manufacture of "activated carbon" in coconut-producing countries, although one large shipping firm in Ceylon installed plant for granulating crude charcoal, which in granular form (ready for processing) was supplied for French requirements up to 1939. The possibility of the local manufacture of active carbon has been considered in the Philippines, in India and in Ceylon, and reference will be made in the next article of this series to the preliminary investigations carried out in these countries.

PREPARATION OF SHELL CHARCOAL

Shell charcoal is usually burned in pits, which may be anything from a simple hole in the ground to large brick-lined pits with steel lids. Accounts of the procedure adopted in Ceylon are given by Cooke (1932)[53] and by Child (1940).[54] Similar accounts have been published in attempts to encourage production in other countries; these include, for Malaya, an article by Cooke (1935),[55] and for Fiji, a note by Jack (1940).[56] In New Guinea, Hutchinson has described a method of burning shells in 40-gallon oil drums (1941).[57]

Up to the present patent steel and brick-work kilns such as the Hornsby Patent seem nowhere to have come into use. In the writer's opinion, a portable type of kiln such as has been used in England during the War (1944)[58] would be very suitable for a raw material like coconut shells, production of which is scattered.

The production of retort charcoal by carbonization with recovery of by-products is now

carried out in the Ceylon Government Acetic Acid Factory. Further reference will be made to this in a later article on Distillation of Shells.

It may be remarked here that shell charcoal burning in pits is not a pleasant occupation either for those who conduct it or for dwellers in the neighbourhood. The smoke is peculiarly acrid and deleterious to metal work and fabrics. Charcoal burning has, in fact, been held by a Ceylon court to be a "nuisance" trade.

Yield of Charcoal

The yield of charcoal from pit burning of shells averages between 29 and 30 per cent. by weight of the original shells, when the operations are efficiently conducted on clean dry shells. Adopting a figure of 29 per cent. Table II (*b*) of Article III of this series[41] can be extended to show the relation between out-turn of copra per 1,000 nuts, and the number of shells required to make a ton of charcoal. A usual working average is that 20,000 whole dry shells go to a ton of charcoal (this corresponds to 4,400 nuts per long ton of copra).

It may thus be estimated that in Ceylon in 1939, some 360 million whole shells (= about 60,000 tons) were converted to charcoal or about one-fifth of the Island's total production (*cf.* above Table I and also Table I of Article III, ref. 41, p. 150). Charcoal production could not have expanded much beyond the 1939 output, since some 60 per cent. of the shells produced annually are used for copra drying. Nevertheless, the Ceylon authorities were subjected to ill-informed criticism early in 1940 for failing to secure a possible contract for a further 2,000 tons a month.[59]

Quality of Pit Charcoal: Importers' Specifications

Good quality coconut shell charcoal should be uniformly black in colour and free from carbonised fibre (from adhering husk on the original shell). Broken edges should show a shining black surface and the characteristic sharp conchoidal* fracture. Dropped on a stone floor well-burned pieces give a clear ring; under-burned pieces a dull sound. Over-burned pieces are very thin and brittle, and are not favoured for inclusion in samples for export as they easily go to dust.

Besides over- or under-burning, common faults of pit charcoal are (*a*) excessive moisture, due to too much water being used to damp down when opening the pit, (*b*) high salt content, due to brackish water being used to damp down, (*c*) contamination with sand or earth. Importers' specifications aim at limiting these faults.

Such specifications nearly always impose limits for moisture, ash and volatile matter, and some include limits for chlorides, water-soluble matter and alkalinity. They usually also have limits for sizes of pieces as determined by screening through sieves of various mesh. Table IV gives a summary of importers' specifications.

* *i.e.*, "a fracture presenting smooth shell-like convexities and concavities" (*Oxford English Dictionary*).

Methods of Examination

(*a*) Sampling in the case of bulk products such as minerals, coal, soil, copra and charcoal, presents considerable difficulties. Analytical determinations on charcoal are performed on powdered quantities of a few grams and it is apparent that great care must be exercised in order that such small samples shall be truly representative of the original bulk.

In drawing from bulk the primary sample to be sent for examination, it is necessary to open and sample more bags than is usually recognized. A useful rule, which has been found adequate for copra[61] and for feeding stuffs,[62] is to take a number of bags equal to the square-root of the total number. In the case of charcoal, this number of bags should be opened and turned out, each lot mixed up, and three pounds drawn from each lot. The quantities so drawn are bulked.

Further sampling by the analyst is (according to Specification E) done as follows. The sample received is reduced to 5 lbs. by direct quartering; this amount is broken through quarter-inch mesh and again sampled by quartering down to 1 lb. This is broken through an eight-mesh sieve and quartered down to 100 gms. From this final sample is drawn 30 gms. which is finely ground through a sixty-mesh, and used for determination of moisture, ash and volatile matter.

(*b*) *Moisture.*—According to Specification E, 20 gms. powdered charcoal (sixty-mesh) are dried at 110° C. for two hours, cooled in a desiccator and weighed. D uses 1 gm. powdered charcoal and dries at 120° C.

(*c*) *Ash.*—According to E, 2 gms. of the dry charcoal from the moisture determination are ashed in a muffle furnace; being first burned off at a low temperature and finally at 950° C. for 1½ hours. In the writer's experience (see below) it has been found preferable to determine the sulphated ash, since it is somewhat difficult to get consistent results by the above method owing to the volatility of potassium salts in the ash.

(*d*) *Volatile Matter.*—The "volatile matter" is an arbitrary comparative figure depending on the method of determination adopted.

E proceeds as follows: Into a weighed porcelain crucible (without lid) of diameter 1¼", 1 gm. powdered charcoal from the moisture test is weighed. The crucible is placed in a Davies Crucible Furnace, and heated by means of a Téclu burner at 950° C. for exactly 7 minutes; cooled in a desiccator and re-weighed.

According to Specification B: volatile matter is determined by heating over a Bunsen burner in a closed platinum crucible for 10 minutes.

The French Specification D heats the charcoal in a closed crucible contained in a larger crucible packed with dry charcoal so that the smaller crucible does not come into contact with the flame (1 hour at 700-800° C.).

The writer was not able to obtain very concordant results by the last method. The first method was preferred and gave results satisfactory for comparative purposes.

(*e*) *Water-Soluble Matter.*—For this and the following two determinations, Specification E

TABLE IV
Specifications for Commercial Shell Charcoal

	A	B	C	D	E
	London firm (Cooke, 1935, Ref. 55)	London firm 1936[60]	Manchester firm 1936[60]	French firm 1936[60]	Manchester firm 1937[60]
Moisture. Not more than ..	10%	5%	10%	5–6%	10%
Ash. Not more than	..	3–4%	..	1–2%	2%
Volatile matter. Not more than	15%	15%	15%	12–16% (sample rejected if over 20%)	30%
Chlorides. Not more than ..	..	.	(see below)	.	1·0 mg./gm. (but should be below 0·5 mg./gm.)
Water-soluble matter. Not more than	..	..	..	..	0·5% (but should be below 0·25%)
Alkalinity. Not more than ..	..	..	..	..	0·5% (but should be below 0·2%)
Size	Not < 10% on 1″ mesh Not > 5% passing ¼″	..	Not < 10% on 1″ mesh Not > 10% passing ¼″	..	On 1″ not < 10% Thro' 1″ on ½″ 10–20% ,, ½″ on ¼″ 30–40% ,, ¼″ on ⅛″ 15–25% ,, ⅛″ on ¼″ 10–20% ,, ¼″ not > 5%
Other remarks	..	..	Free from contamination with salt water. Free from foreign matter. Shells to be of good thick quality.	..	..

uses the remainder of the coarse (eight-mesh) 100 gm. sample. Ten grams are added to 100 c.c. of boiling distilled water, boiled for 10 minutes, filtered and washed with 50 c.c. of cold distilled water. The filtrate is evaporated and the residue dried at 110° C. and weighed.

(*f*) *Alkalinity (or Acidity) and Chlorides.*—Ten grams coarse sample are treated as in (*e*) and the filtrate titrated to methyl orange with N/10 sulphuric acid (or caustic soda if filtrate is acid). Results are expressed as c.c. N/10 acid (or alkali) per gm. of dry charcoal.

Chlorides are determined on the so neutralised filtrate by titration with standard silver nitrate solution, using chromate indicator; expressed as mg. C/1′ per gm. of dry charcoal.

The writer has determined chlorides (see below) on the soluble ash. The results are reasonably concordant with those obtained by the foregoing method.

All determinations except (*b*) are expressed as per cent. of *dry* charcoal.

(*g*) *Screen Test.*—Specification E recommends that at least a 1 kilo. sample should be used. The writer prefers a larger sample if available. Each screen is well tapped until no more sample passes through.

RESULTS OF EXAMINATION OF COMMERCIAL SAMPLES

Thirteen samples locally produced[9] have been examined by the writer.

[9] i.e., in Ceylon.

(*a*) *Moisture.*—Only five samples had moisture per cent. below 5; all but one, however, were below 7 per cent. and that was 8·1 per cent., the mean being 5·5 per cent. A specification limit of 5·0 per cent. seems rather stringent and 7·5 per cent. is suggested.

(*b*) *Ash.*—The range of figures for ash on eleven samples was 0·8 to 2·2 per cent., only one however being over 1·6 per cent., with a mean of 1·3 per cent. Sulphated ashes (13 samples), ranged from 1·2 to 3·2 per cent., only two samples (2·1 and 3·2 per cent.) being over 1·9 per cent.; mean 1·7 per cent.

A specification limit of 2·0 per cent. seems quite satisfactory. The two samples which failed to pass this specification were known on other grounds to be bad. That high ash figures indicate contamination with sand or soil is shown by the results of ash determinations on material which passes a quarter-inch or sixth-inch mesh:—

SAMPLE I

Passing ¼″ mesh	2·6% (Specification limit 5·0%)
Ash on material remaining on ¼″ ..	1·50%
Ash on material passing ¼″	16·2%
Ash on sample as received	1·92%

SAMPLE II

Passing ⅛″	5·4%
Ash on material remaining on ⅛″ ..	1·1%
Ash on material passing ⅛″	11·2%
Ash on sample as received	1·64%

It may be observed that an average ash content of 1·7 per cent. of the charcoal corresponds to 0·58 per cent. ash on the original shells, which is in accordance with the figures of Phillips and Goss (1940),[4] Georgi (1941)[5] and the writer (1938)[2] quoted in the first article of this series (1943, p. 292).[17]

(c) *Chlorides.*—Twelve samples examined by the writer averaged 0·41 mg. Cl′/gm. dry charcoal. Four samples exceeded 0·5 mg. Cl′/gm., three of these only slightly; the other sample (1·34 gr. Cl′/gm.) was one of those referred to above as known to be unsatisfactory. Specification E is thus a reasonable one.

A figure of 0·41 mg. Cl′/gr. dry charcoal corresponds to ·014 per cent. Cl′ on the original shells or 2·1 per cent. Cl′ on the ash (*cf.* ref. 17).

(d) *Volatile Matter.*—Using the French method the writer obtained high and variable results and the first method was preferred. Of twelve samples, six gave figures below 15 per cent., three between 15 and 20 per cent., two slightly over 20 per cent. (21·2 and 21·9) and one 29·5 per cent. The last sample was obviously under-burned; omitting this, the average was 16·0 per cent. A limit of 15 per cent. is perhaps a little stringent; 30 per cent. is unnecessarily tolerant.

(e) *Screen Test.*—Importers do not insist on accurate compliance with such a detailed specification as E, but expect other limits of not less than 10 per cent. to remain on a one-inch mesh, and not more than 5 per cent. to pass a quarter-inch to be observed. There is some breaking up in transport, but less than might be expected.

Other Properties of Commercial Coconut Shell Charcoal

Elementary analyses for carbon, hydrogen and oxygen do not appear to have been recorded for coconut shell charcoal. What is referred to as "Fixed Carbon" is the figure obtained by deducting the sum of percentages of moisture, ash and volatiles from 100. Thus a sample of shell charcoal from Ceylon examined by the Imperial Institute in 1916[63] was reported as moisture 4·7, volatile (at low red heat) 18·2, Ash 1·0, fixed carbon 76·1. Total 100·0 per cent.

Calorific Value

The same sample was reported as having a calorific value of 7,529 cals. per gm. Cooke (1935)[53] found a gross calorific value of 7,640 cals. per gm. dry weight. Expressed in B. Th. U. per lb., the calorific value of coconut shell charcoal should not be less than 13,000.

Sulphur

The Imperial Institute (*loc. cit.*) found 0·05 per cent. sulphur in the sample examined by them. This was probably present in the form of potassium sulphate and is in any case negligible.

Cost of Making Pit Charcoal

It is perhaps not very useful at the present time to discuss the cost of producing pit charcoal from coconut shells since what details are available relate to pre-1940 conditions. The figures given for Malaya by Cooke[53] and for Ceylon by Child[40] may, however, have some comparative value.

According to Cooke, in Malaya in 1935, charcoal was being manufactured and bagged on contract at 28 Straits cents per picul. Cost of bags, handling and road transport brought the total to about 60 cents per picul f.o.b. Singapore (or about Rs. 16 per ton).

Child, writing in early 1940, stated that in Ceylon a usual contract charge for burning shells, sorting and bagging was Rs. 4·00 a ton. Bags cost Rs. 3·00 and transport about 20 cents per ton mile. The cost f.o.b. Colombo was, therefore, from localities about 30 miles from Colombo about Rs. 13·00 per ton plus value of shells. Taking the latter at Rs. 1·50 per 1,000, this gives a cost at Colombo of Rs. 43·00 per ton, assuming 20,000 shells to a ton of charcoal. In practice, the cost of shells became in Ceylon dependent on the demand and price paid for charcoal (see Article II, ref. 31, p. 5). The industry did not develop in Malaya despite its lower costs, presumably because of the longer distance and higher freight to Europe.

Packing, Storage and Shipment

Since accidents have occurred both by sea and land through cargoes or stocks of charcoal becoming re-ignited (spontaneous combustion is doubtful), it is made a condition of shipment that charcoal shall be spread out and freely exposed to the air for at least fourteen days before packing. It is usually packed in strong gunny bags (coir bags have been used) containing 90 to 130 lbs. (generally 1 cwt.). Twelve 1 cwt. bags go to the shipping ton (50 cubic feet).

The shipment of granulated charcoal already referred to had distinct advantages on account of more economical stowage, besides the preference of buyers for charcoal in a partially prepared state for activation.[64]

Long storage (for over six months) is found to result in deterioration of the bags by chemical action, and bulk storage is preferable when immediate shipment is not possible. Obviously such storage must be in dry godowns. Bulk storage and consequent rehandling has the disadvantage of breakage leading to an increase of smalls and dust; rescreening may become necessary.

Uses of Coconut Shell Charcoal

Shell charcoal was developed from a minor local product used as fuel and in gas producers to a general commercial product owing to its value as a raw material for the production of Active Carbon. This forms the subject of the second section of this article.

Before concluding this section, however, brief reference must be made to the possibilities of coconut shell charcoal as a fuel for gas producers for motor vehicles.

Gas Producers for Motor Vehicles

It is not necessary here to discuss at any length the general subject of gas producers for motor vehicles, especially as a detailed review has recently been published by the Imperial Forestry Bureau (1942).[65] Reference may also be made to a leaflet of the Forest Research Institute, Dehra Dun (1942),[66] on

the subject of the quality of charcoal required for producer gas plants.

Little study seems to have been devoted to the possible use of coconut shell charcoal for this purpose. The writer made certain enquiries in Ceylon and S. India in 1942-43 from users of automobile gas producers, some of whom stated that commercial shell charcoal tried by them contained too high a percentage of tar products with the result that the gas filters became clogged very quickly and tar fouling of the pistons and valves occurred. The distillative products of shells differ somewhat from those of wood (see Article V of this series) and it is possible that their more phenolic nature tending to resinous tar formation may be a drawback to the use of shell charcoal in this field. On the other hand, it is possible that a higher grade of retort charcoal would be suitable and it certainly seems desirable that further investigations should be carried out. The utilization of shell charcoal in this way would be of economic interest to coconut-growing countries. The writer would be glad to hear of any information obtained from trials on this subject carried out by investigators in India.

REGINALD CHILD.

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JOURNAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

IT is a matter of great satisfaction that during the short span of two years and a half, the *Journal* has established itself not only as the official organ of the Council of Scientific and Industrial Research but also as the *Journal* to whom the world will look to as the medium reflecting the progress of industrial research in this country. The *Journal*, published as a quarterly at its inception, has now been made into a monthly to meet the growing demand for the prompt publication of the results of industrial research pursued in the various laboratories. Further, the Journal has been largely responsible for establishing the long-felt *liaison* between the industrialists and the scientific workers.

The get-up and format of the *Journal* have been greatly improved and considering the difficult times during which this journalistic enterprise has been launched, the *Journal* has to its credit a record of substantial progress. The Editorial Board and the distinguished Editor deserve to be heartily congratulated.

AN ELECTROLYTE-FREE MEDIUM FOR UNSTRIATED MUSCLE

By INDERJIT SINGH, F.A.Sc.

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IT is generally believed that muscle becomes inexcitable in the absence of sodium chloride, and that calcium is necessary for the contraction of plain muscle. It was found, however, that *Mytilus* muscle could contract, if deprived of calcium for an hour, and subsequently treated with sodium citrate (Singh, 1937) and frog muscle in the complete absence of sodium chloride and calcium (Singh and Mrs. Singh, 1943).

It has been further found that frog stomach is able to contract and respond normally to stimuli in the absence of all electrolytes (8 experiments) and guinea-pig uterus feebly (2 experiments), if the osmotic pressure is reduced by 50 per cent. by immersing in a half-tonic solution of sucrose (B.D.H., A.R.), the osmotic pressure of which corresponding to about 0·3 per cent. sodium chloride or 0·11 M sucrose. Glucose is not so good as sucrose in this respect.

The frog muscle was immersed in the sucrose solution, which was renewed every 15-30 minutes. At first the excitability is depressed the spontaneous contractions, having ceased, the muscle passing into a tonic contraction, but after an hour or more it begins to recover. The spontaneous contractions may be twice as big as in the saline solution. The muscle responds to alternating current, the isometric contraction being 30-70 per cent. of that in saline solution, and to direct current, the isotonic contraction being just as big as in saline soluion. Unfortunately, owing to the war situation, acetylcholine was not available. Adrenaline produces inhibition as in the normal medium.

After recovery the muscle responds for about 2-3 hours after which the excitability diminishes. After about 4 hours the response to electric current is abolished, though the spontaneous contractions persist for about 6 hours. It then passes into contracture.

The frog stomach muscle is a thin flat muscle, about one mm. in thickness, so that diffusion must be rapid; this does not apply to the guinea-pig uterus. The medium was free of electrolytes, though there are bound to be traces of ions diffusing out of the muscle. The conductivity of the solution was low as measured previously. How is it then stimulated electrically? If traces of ions conducted the current the strength of the current should fall below the threshold value, which for plain muscle is high. The muscle is then either hypersensitive to electric current, or is stimulated by the electric field, the muscle, solution and the electrodes forming a condenser. As there are hardly any ions outside, excitation is undoubtedly caused by mobilisation of ions inside the muscle fibres; so also the spontaneous contractions, as mentioned previously (Singh, 1939). In such excitation, therefore, the question of increase in permeability to permit ions to enter from the exterior does not arise. It has been found that during stimulation of muscle, there is no increase in permeability (Fenn, Noonan and Huage, 1941).

It is probable, that to produce their effect, the ions enter or get fixed to the muscle membrane, and when the muscle is deprived of electrolytes, these ions are only slowly liberated, thus preserving the properties of the membrane.

When the muscle is actively contracting, restoration of the normal osmotic pressure of the saline (the osmotic pressure may be increased above normal), causes a tonic contraction and depression of excitability. The reduction of the osmotic pressure of the solution will cause a dilution of the ions within the muscle fibres, so that it is clear that tonic contraction and depression of excitability is due to the action of ions inside the muscle fibres.

The muscle membrane is thus excited, if excess of ions, say potassium, is applied to its outer or inner surface. This will have a bearing on the mode of action of nerves. These may end outside the fibres or inside. If acetylcholine is liberated outside, then atropine would antagonise it. If, however, acetylcholine is liberated inside the cells, then atropine would not antagonise it, if the cells are not permeable to it. Dale has advanced such an explanation for the inability of atropine to antagonise certain cholinergic nerves; it is presumed that atropine is unable to reach the seat of action.

Diminution of potassium in the saline in certain instances, would cause a depression of excitability, by increasing the depressent action of ions inside the fibres; excess of potassium outside would directly cause a depression of excitability, so that an optimum concentration of potassium would be necessary. In familiar periodic paralysis, the reduction of the serum potassium (Aitken, Allott, Castleden and Walker, 1937), would cause a similar depression of excitability.

Excess of potassium outside the muscle fibres produce a tonic contraction and depression of excitability, which is antagonised by increase in osmotic pressure of the saline (Singh, 1939), by increasing the concentration of ions in the muscle fibres. The action of ions outside the muscle fibres is thus antagonised by those within and *vice versa*. A difference in concentration of ions on two sides of the muscle membrane thus causes a contraction, and depression of excitability. This may be related to potential difference on two sides, which is affected by changes in osmotic pressure (Cowan, 1934).

The action of ions on two sides of the membrane is thus antagonistic. Excitatory state on one side of the muscle membrane would be antagonistic to that on the opposite side, but

would be synergistic to an inhibitory state. Excitation may thus be caused by the following possible methods: (1) Increase of external excitatory state (*e.e.s.*). (2) Increase of internal excitatory state (*i.e.s.*) (3) External excitation by increase of internal inhibitory state (*i.i.s.*). (4) Internal excitation by increase of *e.i.s.* (5) External excitation by diminution of *e.i.s.* (6) Internal excitation by diminution of *i.i.s.* (7) External excitation by dimunition of *i.e.s.* (8) Internal excitation by diminution of *e.e.s.*

Of these eight conditions, the first has been experimentally produced by addition of excess of ions, such as potassium to the outside of the muscle, the second by increase of osmotic pressure (Singh, 1942), the third probably by adaptation to alternating current (Singh, 1944), the fourth by addition of ammonium outside and simultaneous increase of osmotic pressure of the saline (Singh, 1939; 1944), the fifth by removal of calcium (Sing, 1938), the sixth has not been produced, the seventh by decrease of osmotic pressure of the saline, the eighth by immersion in sucrose solution. Experiments thus fit into the theory.

Inhibition would be produced by opposite methods respectively: (1) Decrease of *e.e.s.*, such as by partial removal of sodium chloride from the guinea-pig uterus. (2) Decrease of *i.e.s.*, by the hypotonic sucrose solution. (5) External inhibition by increase of *e.i.s.*, by calcium in *Mytilus* muscle. (6) Internal inhibition by increase of *i.i.s.*, by adaptation to alternating current. The rest have not been obtained experimentally.

Adaptation would be due to leakage of ions or to the production of a like state on the opposite side of the membrane. An excitatory substance on diffusion to the opposite side will become inhibitory and *vice versa*. This is in agreement with views of Wright (1942), who finds that anticholinesterases act as depressants outside the nerve-cells, but as convulsants inside.

Tone and slow relaxation appears to be caused by ions within the muscle fibres as well. How small concentrations of drugs act, it is not clear as yet.

1. Aitken, Allot, Castleden and Walker, *Clin. Sci.*, 1937, 3. 2. Cowan, S. L., *Proc. R. Soc.* B, 1934, **115**, 216. 3 Fenn, W. O., Noonan, T. R., and Haege, L., *Amer. J. Physiol.*, 1941, **35**, 149. 4. Singh, I., and Mrs. Singh, I, *Proc. Ind. Acad. Sci.*, 1943, **18**, 58. 5. —, *J. Physol.*, 1936, **89**, 10; 1938, **91**, 398; 1939, **96**, 367; *Ind. Journ. Med. Res.*, 1942, **36**, 29; *Proc. Ind. Acad. Sci.*, 1944, **19**, 91.

THE DEPARTMENT OF INDIAN POSTS AND TELEGRAPHS

AN official publication describes the story of communications as set against a background of vast distances, varying climatic and geographical features, of hundreds of languages and dialects, of illiterate persons who have incomplete addresses written out for them, of 400 million people, more than 85 per cent. of whom live in 700,000 villages, of how one-fifth of the human race spread over an area as large as Europe, excluding Russia, keep in touch with one another. It is learnt that though the generation associating its mails with runners has long passed, runners and boats still convey mails over 84,000 miles out of a total of 157,000 miles. The Department disposes of 1,475,000,000 unregistered articles in a year and the number of complaints received is said to be 1 for every 100,000 articles. This would lead one to believe that the people are averse to complain and that the machinery for receiving and accounting for complaints needs overhauling.

Owing to the growing needs of the Defence Department in 1942, an extensive scheme estimated to cost 17 crores of rupees, of erecting telegraph and telephone channels was put in hand and is scheduled to be completed in 1944-45. The Department was called upon to manufacture communication equipment in very large quantities for the Armed Forces. Vast expansion of existing workshops was undertaken and a new workshop was established in Central India at a cost of over 30 lakhs of rupees. Even this was found insufficient and 91 other workshops large and small were employed in the manufacture of stores. The cost of these was Rs. 61,95,720 in 1938-39 and it rose to Rs. 48,346,000 in 1943-44.

The acquisition by the Department, of telephone systems owned by private companies at Calcutta, Bombay, Madras, Karachi and Ahmedabad is an event of considerable importance from the point of view of long-term planning and development. One can only hope that the red-tape associated with the Government machinery will not be allowed to impair the efficiency of service.

The Department is run on commercial basis and it is stated that the increased rates and surcharges are not a part of Department's financial policy but are aimed at raising revenue for the war effort. It is heartening to note that it is first and foremost a public utility service whose principle objectives are cheapness and efficiency. One would in this connection suggest the grant of a bonus to the workers out of the profits, or the introduction of co-operative principles in any other form so that the workers may feel that they stand to benefit both by economy and efficiency.

LETTERS TO THE EDITOR

THE *LIGHT-EFFECT* UNDER ELECTRICAL DISCHARGE: THE PROBABLE TIME-LAG IN ITS PRODUCTION

Discovered originally[1] as a small increase, on irradiation, of V_m the 'threshold potential' required to initiate discharge at a given gas pressure, subsequent work has shown that the above influence is of wider occurrence and of a greater order of magnitude than a 'residual phenomenon'. It was shown[2] that i, the discharge current, depends chiefly on $V - V_m$ where V is the applied potential. From this it follows that under conditions, *e.g.*, irradiation which increase V_m, a diminution of current Δi, should occur. This prediction has been fulfilled in numerous cases without exception and is perhaps the simplest way of investigating the phenomenon.[3,4,5]

It was observed from the very beginning of this work, that whilst the start of Δi the light effect is practically instantaneous, its full value is attained only after an appreciable time, as shown by a sensitive ballistic galvanometer actuated by an A.C. rectifier or a vacuo-junction which carried i the discharge current. This remark applied also to the reverse change, i.e., when i_1 increased to its original value in dark on screening off the light. With improved knowledge of the chief determinants of this phenomenon, it has been possible to obtain Δi as high as 93 per cent.[5] Short period, dead beat type galvanometers could, therefore, be employed despite their comparative insensitivity. This reduced markedly the hitherto appreciable interval between the act of irradiation and observation of Δi to about 1-2 seconds. It is found, however, that the inertia of the galvanometer suspension and especially the heat conductivity of the vacuo-junction set a lower limit to the time in which Δi may be observed.

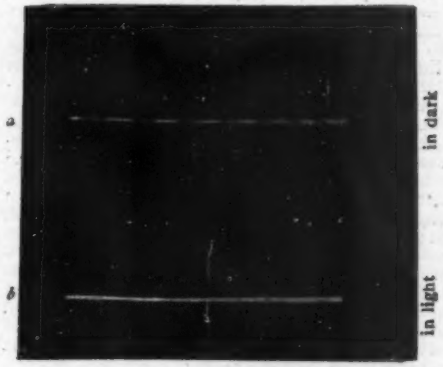


Fig. 1

Oscillograms of the discharge current

That any time-lag inherent in this effect may well be shorter than the above period was seen, when the mode of its observation was varied. The discharge current i was allowed to flow through an iron core transformer; its secondaries were connected to an amplifier and a loud-speaker. This produced a characteristic group of notes, when the chlorine tube, screened from light, was excited by

applying a suitable potential. The volume of this sound *decreased* sensibly and as far as could be judged, practically instantaneously on irradiation and *vice versa*.

This conclusion is supported by studies of the light-effect that were made with a cathode-ray oscillograph.[4] This was introduced in place of the loud-speaker in the previous arrangement. It is found that a large number of frequencies besides, and much higher than, that of the A.C. supply constitute i, the discharge current (Fig. 1*a*). The amplitudes of these frequencies are reduced to a very marked extent immediately on irradiation (Fig. 1*b*).[4] This reveals a significant factor in the mechanism of the light-effect. The change

$$a \underset{\text{dark}}{\overset{\text{light}}{\rightleftharpoons}} b$$

is reversible; the corresponding period, i.e., any time lag in its occurrence lies within the limits of visual persistence.

Chemistry Department,
Benares Hindu University, S. S. JOSHI.
September 17, 1944.

1. Joshi, *Curr. Sci.*, 1939, **8**, 548. 2. —, *Trans. Faraday Soc.*, 1927, **23**, 227; 1929, **25**, 108, 138. 3. —, *Presidential Address, Chem., Sec., Ind. Sci. Cong.*, 1943. 4. —, *B.H.U. Journ.*, 1943, **8**, 99. 5. —, and Deo, *Nature*, 1944, **153**, 434.

SPECTROSCOPIC INVESTIGATION OF THE EFFECT OF MAGNETIC FIELD ON ELECTRICAL DISCHARGE IN GASES

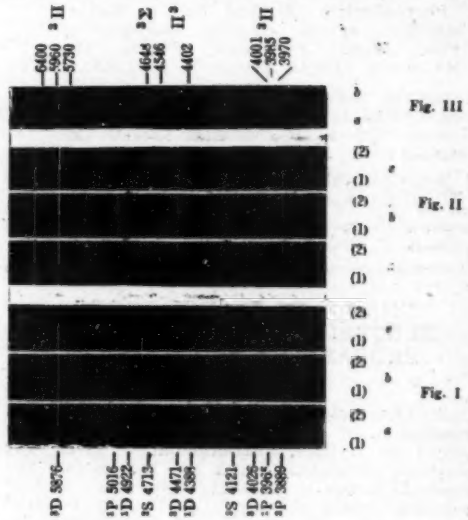
IN the Zeeman Effect experiment usually performed in the laboratory with a neon tube, it is observed that the magnetic field, besides producing the well-known splitting of the lines, affects to a marked extent the intensity of the glow in the discharge tube. It was thought that a detailed spectroscopic investigation of the effect of magnetic field on the variation in the intensity distribution amongst the spectral lines, would give useful information about the collision processes involved in the mechanism of discharge of electricity in rarefied gases. Preliminary experiments with helium, neon and hydrogen have revealed some interesting facts which are set forth in this note. The experiments were performed with the ordinary capillary discharge tubes placed between the poles of an electro-magnet capable of giving a field upto 10,000 gauss. The tubes were worked between 10 and 15 kilovolts. The results of observations may be summarised as follows:—

(i) The intensity of the lines increases with the magnetic field, reaches a maximum and then decreases, the decrease being more rapid than the increase. This is shown in Fig. 1 (*a*, *b*, *c*) in the spectrum of helium, where the lower strips (1) give the spectra in zero field, and the upper strips (2) in fields of 4,000, 6,200 and 7,800 gauss respectively.

(ii) The field at which a line reaches its maximum intensity, the conditions of pressure and excitation remaining the same, depends on two factors (*a*) the wave-length and (*b*) the presence of foreign gas.

The dependence on wave-length was best exhibited with the Balmer series of hydrogen. $H\delta$ appeared as a weak line in zero field, reached a maximum intensity at 4,000 gauss, after which the intensity fell off rapidly and the line was not excited at all at higher fields. $H\gamma$ reached its maximum intensity at 6,000 gauss, whereas $H\beta$ and $H\alpha$ showed a continuous increase in intensity even upto 10,000 gauss, the maximum field obtainable in the experiment.

The effect of foreign gas on the intensity of the lines is shown in Fig. 2 which gives the spectra of a mixture of helium and neon. In the three strips the lower halves marked (1) are for zero field, and the upper halved marked



(2) are for fields of strength 4,900, 7,000 and 8,200 gauss respectively. It is to be noted here that, in contrast with Fig. 1, the lines continuously increase in intensity without showing a maximum. The effect of the foreign neon gas seems to be to increase the field strength at which the helium lines will have their maximum intensity.

(iii) For a given applied potential at the terminals there is what may be called a "critical" field at which the discharge stops altogether and the tube becomes non-conducting. As this critical field is approached, and just before what may be called the "throbbing" state of the tube, the intensity in the capillary portion (which is kept in the magnetic field) is considerably reduced and the intensity of the glow in the wider portions of the tube, near the electrodes, is correspondingly increased. Fig. 3 is the spectrum of helium from the *wider portion* of the tube in this state (*a*) without the field and (*b*) with the field which under the conditions of the experiment, is found to be 6,200 gauss. It will be observed that without the field only the weak atomic spectrum is produced, while with the field on,

not only is the intensity of the atomic lines increased but the molecular spectrum of helium is fully brought out. The spectra from the wider portions of the tube for lower values of the field at the capillary, showed only the atomic lines. It is to be inferred that he excitation of the helium molecule bands is a sudden process occurring within a narrow range of field strength near about the "throbbing" field. Most of the He_2 bands are identified with the triplet electronic states, and they involve only the two lowest states $2p\pi^3\Pi_g$ and $2s\sigma^3\Sigma_u^+$.

I wish to express my grateful thanks to Dr. A. S. Ganesan for his kind guidance.

Physics Department,
College of Science,
Nagpur, S. B. KULKARNI.
September 26, 1944.

ELASTIC BEHAVIOUR OF METALS NEAR THE MELTING POINT

THE velocity of sound in metals in the solid state, just below the melting-point, is about twice as great as that of the liquid metal, just above the melting-point. Certain abnormal metals, however, such as bismuth, show an increase in velocity in the liquid state. The mathematical relation between the velocity of sound and elastic modulus for a solid and the coefficient of compressibility for a liquid are well known. They involve only the properties stated and the density. The abrupt change in the velocity of sound and the elastic properties, is explained on the basis of the harmonic model developed by Fowler and Guggenheim.[1]

It is well known that the frequency of vibration of atoms in the solid is dependent on the elastic constants. Considering an isotropic solid and assuming that the atoms are vibrating about mean fixed positions with a single frequency ν_K, it may be easily shown that the atomic frequency is proportional to $\frac{v_K}{\sigma_K}$ where v_K is the velocity of sound for longitudinal vibrations and σ_K is the mean molecular distance in the solid given by $\left(\frac{V_K}{N}\right)^{\frac{1}{3}}$, V_K being the molecular volume and N the Avogadro number.

Considering the liquid near the melting-point as an assemblage of a large number of linear harmonic oscillators, each vibrating with a frequency v_L about a slowly displaced equilibrium position it is easy to show that the frequency ν_L is related to the velocity of sound by the relation

$$\nu_L = v_L \left(\frac{3N}{4\pi V_l}\right)^{\frac{1}{3}}.$$

The above model, although crude, has been applied to explain the viscosity of molten metals by Andrade[2] and surface tension by Sibaiya and Rama Rao[3] and thermal conductivity by Rama Rao.[4]

On the assumption that the densities of the molten and solid metal are the same at temperatures just above and below the melting-point, it follows that

$$\frac{\nu_K}{\nu_L} = \frac{v_K}{v_L} 0{\cdot}75 \qquad (1)$$

On the basis of the harmonic oscillator model for the liquid and the solid, the partial potential of liquid at ordinary pressure is given by

$$x_0^L = -x_0^L - 3k\,T \log \frac{kT}{h\nu_L} - kT + kT \log J^L\ (T)$$

where the superscript L refers to the liquid. For the solid the partial potential is given by

$$F^K = -x_0^K - 3k\,T \log \frac{kT}{h\nu^K} - kT \log J^K\ (T)$$

where the superscript k refers to the solid. Assuming that there is no discontinuity between the internal degrees of freedom in the solid and the liquid, the melting temperature temperature T_m is given by

$$\frac{x_0^K - x_0^L}{kT_m} = 3 \log \frac{\nu_K}{\nu_L} + 1$$

Denoting λ_m as the molecular heat of melting we obtain

$$\frac{\lambda_m}{T_m} = 3k \log \frac{\nu_K}{\nu_L} \qquad (2)$$

Hence combining 1 and 2 we have

$$\frac{v_K}{v_L} = \tfrac{1}{3}\, e^{\frac{\lambda_m}{3kT_m}} \qquad (3)$$

Table I gives the values of T_m, v_K and v_L as measured by Stierstadt[5] and the values compared with calculated results.

TABLE I

Metal	Velocity solid (Metres per sec.)	Velocity liquid (Metres per sec.)	T_m in °A	Ratio v_K/v_L	Ratio (Calc.) v_K/v_L
Cadmium	2665	1313	594	2·03	2·16
Mercury	2673	1290	234	2·07	2·10
Lead	1350	699	590	1·93	1·89
Tin	2643	1295	505	2·04	2·08

The agreement obtained between theory and experiment for normal metals is satisfactory. It shows that the lower velocity in the liquid is due to greater amplitude of the atomic oscillations and not to any extent to the irregularity of the arrangement of the atoms, as contrasted with their regular arrangement in the crystalline solid. On the basis of the above theory the decrease in the thermal conductivity of metals at the melting-point has been explained.[6] The formula also offers a method of calculating the compressibility of the molten metals from a knowledge of the elastic constants of the solid.

The elastic behaviour of solids at the melting-point and their relation to the crystal structure will be discussed in a separate note.

Bangalore, M. RAMA RAO.
August 31, 1944.

1. Fowler and Guggenheim, *Statistica Thermodynamics*, 1939. 2. Andrade, *Phil. Mag.*, 1934, **17**, 698. 3. Sibaiya and Rama Rao, *Ind. Jour. Phy.*, 1939, **13**, 293. 4. Rama Rao, *Phy. Rev.*, 1941, **59**, 212. 5. *Stierstadt Metallwirt Schaft*, 8th and 15th Feb. 1932. 6. Rama Rao, *Ind. Jour. Phy.*, 1942, **16**, 155.

A PHOTOELECTRIC METHOD FOR THE DETERMINATION OF THE AVERAGE DIAMETER OF FINE WIRES, FILAMENTS, FIBRES, ETC.

Theory

A beam of light of uniform intensity emerging from a rectangular slit is made to fall on a photoelectric cell producing a current i_1 which is accurately measured. Next, a parallel bunch of fine wires, filaments or fibres, which are opaque to the light, is interposed in the path of the beam. The current is reduced, depending upon the number and average diameter of the fibres, the new current after the interposition of the wires, fibres, etc., being i_2. If it is assumed that the current produced is proportional to the area of illumination, then it can be easily shown that the average diameter of the wires, filaments or fibres is given by the following formula:—

$$d = l/n \cdot \frac{i_1 - i_2}{i_1},$$

where l is the length of the slit and n the number of wires, fibres, etc., which may be counted either with the naked eye or with the help of a low-power microscope.

The two assumptions necessary for this formula are (1) that the wires, fibres, etc., are opaque to the light and (2) that there is not any appreciable overlapping. If the fibres are not originally opaque, it may be possible to render them opaque by dyeing. The condition for avoiding the overlapping may be satisfied either by mounting the fibres, filaments, wires, etc., individually, or by taking sufficient care in the process of parallisation to ensure that there is no appreciable overlapping. In actual practice it is possible to satisfy both these conditions in most cases.

Apparatus

An apparatus has been designed at the Technological Laboratory which satisfy the abovementioned conditions and enables the diameter of fine wires, filaments or fibres to be measured quickly and accurately. Essentially it consists of a hollow cylinder which is supported on two uprights. An electric bulb is placed at one end of the cylinder, and the current in this bulb is maintained at constant level by means of a sliding rheostat. A condenser and diaphragms are provided to obtain a uniform beam of light which is made to pass through a water cell for the absorption of the heat rays. The light emerging from the water cell passes through a silt which is made exactly rectangular with great care, and the plate of this slit is provided with a suitable stand for holding a slide on which the fibres, filaments, wires, etc., may be mounted. These slides can be interchanged rapidly to enable a fairly large number of readings to be taken on the same or different materials. The photoelectric cell is held at the other end of the cylinder and the light passing through the slit with or without interposition of the fibres, wires and filaments falls upon the photoelectric cell and photoelectric current generated is measured with the help of a galvanometer with a shunt in the circuit.

In the preliminary study single fibres, fine wires of copper, silver, human hair, wool, artificial and natural silk, etc., were mounted individually, and the results of the average diameter obtained in this way were compared with those obtained by microscopic measurements. This method was found to give accurate results. Since, however, mounting of single fibres takes considerable time when as in the case of the textile fibres it may be necessary to examine a large number of them on account of their variability in the later work relating to cotton fibres, a method has been developed in which a parallel bunch of fibers, which is first mercerised and dyed black, is mounted on a slide. The diameter measured in this way is found to agree fairly well with the microscopic measurement. In this way measurements have been mada on wires, fibres, etc., ranging from 20 to 120 microns and good agreement has always been obtained. This method is found to be simple, quick and accurate and has the additional advantage of giving the average diameter. This is particularly useful in measurements where a large number of fibres or filaments have to be examined for their diameter. Apart from fine wires and filaments, it may be used for fibres of wool, cotton, artificial silk, natural silk, etc.

A full account of the method, the apparatus, and the results will appear elsewhere.

Cotton Technological Laboratory,
Matunga, Bombay, Nazir Ahmad.
June 26, 1944. R. L. N. Iyengar.

ACTION OF SODIUM HYPOCHLORITE SOLUTIONS ON COTTON IN PRESENCE OF REDUCED VAT DYES

Nabar, Scholefield and Turner[1] have investigated the effect of reduced vat dyes on the hypochlorite oxidation of cellulose and have shown that an extraordinary increase in the intensity of oxidation occurs when a leuco-vat dye is present on the cellulose. They studied the reaction in greater detail using cotton yarn dyed with Cibanone Orange R^2 and showed that the amount of oxygen consumed was simply related to the various chemical properties such as cuprammonium fluidity, copper number, carboxylic acid groups, etc. of the oxidised cellulose. This behaviour could be attributed to the simplification in the mechanism of oxidation of cellulose. The striking feature of their results, however, was the constant ratio of 2 obtained between the aldehydic and carboxylic acid groups, formed in the products of oxidation which were prepared under different experimental conditions such as pH of the hypochlorite, concentration of the dyestuff on the fibre, etc.

With a view to investigate if similar behaviour is exhibited by other vat dyes, the work was extended to a few vat dyes including those susceptible to chemical modification or destruction. (Well-known example of a dye belonging to the latter category is Indanthrene Blue R which on treatment even with air or mild oxidising agents forms the greenish azine compound.) The chemical properties of the

cotton thus modified were found to show a simple relationship amongst themselves as was the case when the behaviour of Cibanone Orange R. In case of dyes such as Caledon Yellow G, Indanthrene Yellow FFRK, etc., which apparently did not appear to have undergone any modification with the hypochlorite treatment, the ratio between the -CHO groups and -COOH groups formed in the oxidised dyeing was found to be 2. On the other hand for dyes such as Indanthrene Blue R and Ciba Blue 2B which suffered modification as a result of the hypochlorite treatment, the above ratio was found to be 1. It appears, therefore, that the mode of oxidation of cellulose in these two cases is not exactly the same. The work is in progress.

Dept. of Chemical Technology,
The University, Bombay, S. H. MHATRE.
September 18, 1944. G. M. NABAR.

1. Nabar, Scholefield and Turner, *J. Soc. Dyers. Cols.*, 1935, **51**, 5. 2. *Ibid.*, 1937, **53**, 5.

A NEW INDICATOR

AN aqueous extract of Hollyhock flower has been found useful as an indicator in acidimetry and alkalimetry. This indicator is superior to the generally used indicators, *viz.*, methyl orange and phenolphthalein as it can be employed for both weak acids and weak bases. Several varieties of this flower and also some other flowers belonging to the same family have been investigated. The colour of the aqueous extract varies being colourless, faintly green or dirty brown. It, however, changes in all cases to green colour with alkalis and to red colour with acids. The end point in the majority of cases is definite and in case of some flowers it is quite sharp.

The Hollyhock flower, the colour of which is brownish violet at the top and deep violet below towards the calyx region, yields better results. The extract is initially colourless and becomes faintly green in colour on standing. It has to be evaporated until the total solid content in it is about 2 per cent., when it is deep blue in colour and suitable for use as indicator. The titrations have been carried out using this indicator between standard solutions of approximately decinormal strength of hydrochloric acid, oxalic acid and acetic acid with sodium hydroxide, sodium carbonate and ammonium hydroxide, including those between weak acids and weak bases. Wherever possible the titrations have been carried out using other indicators for comparison. The results show an agreement within 0·1 c.c. with the expected readings. Taking the alkali in burette greatly adds to the ease and the accuracy with which the end-point can be determined.

Attempts are being made to analyse the extracts of these flowers in order to separate this indicator and to determine its composition.

Department of Chemistry,
D. A. V. College, D. S. DATAR.
Sholapur, D. R. KULKARNI.
September 7, 1944.

ORGANIC REAGENTS IN INORGANIC ANALYSIS

CUPFERRON or the ammonium-salt of nitrosophenylhydroxylamine, $C_6H_5.N(OH).NO.$, has been widely used for the estimation and separation of different metals. This compound has the following defects which, however, have considerably limited its applicability:—

1. The free nitroso compound is insoluble in water and easily affected by heat and light.
2. The precipitates formed are comparatively unstable towards heat and are also contaminated with the reagent and so direct weighing of the precipitates is not possible.
3. The reagent does not show any specificity towards any particular element or group of elements.

In order to improve upon these defects the following allied compounds are being examined:—

$R{\cdot}N(OH){\cdot}CHO$, (1) $R{\cdot}N(OH){\cdot}CO{\cdot}CH_3$, (2)

$R{\cdot}N(OH){\cdot}CO{\cdot}R$, (3) $R{\cdot}N(OH){\cdot}CO{\cdot}NH_2$, (4)

$R{\cdot}N(OH){\cdot}CO{\cdot}NH{\cdot}R$, (5) $R{\cdot}N(OH){\cdot}CS{\cdot}NH_2$, (6)

$R{\cdot}N(OH){\cdot}CS{\cdot}NH{\cdot}R$, (7)

$R{\cdot}N(OH){\cdot}CS{\cdot}NH{\cdot}CH_2{\cdot}CH{:}CH_2$, (8)

$R{\cdot}N(OH){\cdot}CH{:}N{\cdot}R$, (9) $R{\cdot}N(OH){\cdot}N{:}N{\cdot}R$ (10)

where $R = C_6H_5$. Compared to cupferron all these compounds and the precipitates formed by them with different metallic ions are comparatively stabler towards heat. Many of these reagents are soluble in water and form insoluble salts with comparatively smaller number of metallic ions. Copper has been estimated and separated from lead and mercury (ic) with (3). Titanium has also been estimated gravimetrically and separated from aluminium. Estimations of vanadium, molybdenum, tungsten and iron are in progress. Compound (6) is a versatile precipitating agent like cupferron but the precipitates are stabler and the reagent is enormously soluble in water, so that direct weighing of the precipitates is possible. Compound (7) unlike the parent substance (6) does not give precipitate with Ti^{++++} and Zr^{++++}, whereas the corresponding allyl compound (8) produces good precipitates only with a few elements, *e.g.*, Sn^{++}, Sn^{++++}, Hg^{+}, Hg^{++} and Ag^{+}. A change in pH of the reaction medium has been found to exert profound influence on the precipitating capacity of the reagents, thus increasing their specificity. The results of thorough examination of all the above-mentioned compounds in the form of full papers will be communicated shortly.

My best thanks are due to Sir J. C. Ghosh for his kind interest in the work.

Chemical Laboratory,
Indian Institute of Science,
Bangalore, S. C. SHOME.
September 25, 1944.

A PRELIMINARY NOTE ON THE AGE OF THE SALINE SERIES IN THE PUNJAB SALT RANGE

THE age of the Punjab Salt and its associated marl has been one of the most outstanding controversial problems of Indian geology.

Normally, in the Cis-Indus Range it lies below the known Cambrian beds; while in the Trans-Indus Range its normal position is below the known Tertiary limestones. Some geologists have assigned to the Saline Series the age according to their normal stratigraphical position, having postulated that the two salt deposits are widely different in age. Sir Edwin Pascoe in his memoir[1] has dealt with this subject very exhaustively and has concluded that the Cis-Indus and Trans-Indus salt deposits are of the same age, *viz.*, Tertiary, and that its anomalous position in the Cis-Indus range is due to an overthrust. But this view has been questioned by some of the present geologists of the Geological Survey of India with long experience of field-work in the Salt Range.

A. B. Wyne, one of the earliest authorities on the Salt Range, was in favour of Cambrian age of the Cis-Indus Saline series. In his pioneer work[2] he has stated "that every one who has examined the ground pronounces the salt marl unfossiliferous, but I am not aware that any of it has been subjected to microscopic examination". This view prevailed until recently and it is not known whether the rocks of the Saline series have been subjected to exhaustive microscopic examination in search of micro-fossils. Dr. B. Sahni of the Lucknow University has examined samples of marl and salt sent to him by me from the Warcha and Khewra Mines. The results of part of the work were published in the April 1944 number of *Nature* (p. 462). Most of the samples examined for microfossils have been found to be highly fossiliferous. That all the samples were collected from beds *in situ* either from within the salt seams or from beds immediately below the main seams has been guaranteed by me. It has, therefore, been established that the salt of the Cis-Indus Range is not of Cambrian or pre-Cambrian age but belongs to the Tertiary period.

This settles that the Cis-Indus and Trans-Indus salt deposits are of the same age. It has not yet been possible to determine the exact horizon of the Saline Series from a microscopic examination of the plant fossils. But it can be fixed very accurately because of the lithological similarity of the rocks of the Saline Series with the succession of beds in the Potwar plateau.

The Tertiary beds in the Fatehjang area in the Attock district, and as met with in boreholes of oil wells in the Khaur and Dhulian oil fields, have been classified by Mr. E. S. Pinfold.[3] The junction of the Murree series with the Eocene is unconformable and the basal part of the former is termed the 'Fatehjang zone'. Below this are the Nummulite beds termed 'passage beds' or 'A' beds. Underlying these are the purple shale beds with purple sandstone at top and these are termed 'B' beds. Below these is the fresh-water *Planorbis* Limestone and then the Hill Limestone (Laki and Ranikot), wherein petroleum is believed to have originated. From the stratigraphical position of the Rocksalt in the Trans-Indus Range at Kohat and from analogous petrological characters and the gypseous nature of the series in the Cis-Indus Range, there is little doubt that the Saline Series is identical with the 'B' beds in the oil series. As petroleum originated in the beds below the 'B' beds, the bituminous character and smell of oil in the Trans-Indus salt can easily be understood.

It has, therefore, been established that the age of the Saline Series in the Punjab Salt Range is Upper Eocene (Kirthar). It is hoped that Dr. B. Sahni will be able to confirm this by the isolation of definite forms of microorganisms belonging to this horizon. It is worth mentioning that Purple Sandstone above the Saline Series which had been assigned a Cambrian age heretofore is associated with the Saline Series and there is little doubt that this is also of the same age as the Saline Series, *viz.*, Upper Eocene. Dr. Sahni may be able to confirm this as well by microscopic examination of these rocks, which have been so far pronounced to be unfossiliferous.

Mayo Salt Mines,
Khewra (Punjab), B. S. LAMBA.
August 15, 1944.

1. *Mem. G.S.I.*, 1920, **40**, part 3. 2. *Ibid.*, 1878, **14**. 3. Pinfold, E. S., "Structure and Stratigraphy of N.W. Punjab", *Rec. G.S.I.*, 1918, **49**, 137–60.

A STUDY OF *ACTINOCYCLINA LUCIFERA* AND *CALCARINA CALCITRAPOIDES* OCCURRING IN CALCAREOUS CLAY BED OF NUMMULITIC LIMESTONE SERIES, OF TADKESWAR, SURAT DISTRICT

Introductory.—The Nummulitic Limestone series belonging to Eocene period is well developed at Tadkeswar (21°-22'-30" N. and 73°-4' E.) about 9 miles east of Kim Railway Station.

General.—According to Wynne[1] and Blanford[2] the series is actually divided into ten distinct beds of limestone, calcareous clay, sandstone and conglomerate. Out of these only three beds, namely, Nummulitic limestone and calcareous clay with yellow boulder limestone are of any interest to a palæontologist.

Previous Workers.—Several geologists worked in the area, of whom Wynne,[1] Blanford,[2] Dr. J. Carter,[5] and S. R. Narayana Rao[4] have tried the palæontological side. The species belonging to genii Orbitooides and Calcarina are not mentioned so far by any of these workers—perhaps due to their microscopic nature which make it difficult to trace in the massive limestone. But if we make a detailed search in the residual calcareous clay overlying the massive Nummulitic limestone we find complete

small specimens of the above-mentioned species accompanied by other Nummulites, orbitoides, corals and even few Bryozoa.

1. Phyllum: Protozoa (Foraminifera).
   Genus: Orbitoides (D'orbigney).
   Sub-genus: Actinocyclina: Gumbel.
   Species: *A. Lucifera* (Kaufmann) Fig. 5.
   No. of specimen: Six, two broken.

Description.—Shell almost circular with a central mamelon surrounded by 16 to 18 prominent rays. Diameter of the test for one specimen is 4 mm., while for another it is 5 mm. Eight of the rays start from the centre, the others start at a distance of 1 mm. from the centre. The surface is uniformly finely granulated.

Remarks.—The fossil being very rare no sections were cut. Only from the outward appearance and by comparing with the figures of Nuttal[3] (Pl. 8, Figs. 7-8), and from description given there as described by Kaufmann, the specimen is compared with the species *Actinocyclina lucifera* which has 10 to 16 narrow rays on the surface and a diameter of 5 to 6 mm. The specimen differs from *A. alticostata* Sp. Nov. (Nuttal) of western Cutch and middle Kirthar in having more rays and lesser diameter.

Occurrence.—The specimens were found in the calc-clay overlying compact Orbitoidal limestone bearing Calcarina, Assilina, south-east of Tadkeswar.

2. Family: Rotalidæ.
   Genus: Calcarina (Zittel).[6]
   [Baculogypsina (Narayanrao)[4]]
   Species: *C. calcitrapoides* (Figs. 1, 2, 3, 4).
   No. of specimen: About 100, few others embedded in the massive rock.

Description.—Test vitreous perforate discoidal with dissimilar upper and lower surfaces; chambers spirally wound, clearly seen in thin sections. Spiral canal system present but no marginal cord. Exterior encrusted with granules which often resemble those of Discocyclina. These granules are over the supplemental skeleton which fills up all depressions and builds spiny or spur-like appendages traversed by coarse canals. The spine vary from two to eight in number. Complete specimen of eight spines are rare. Most perfect specimen are four-rayed with the rays in one plane at an angle of nearly 90°. In few specimen having five or six spiny rays the arrangement is not in one plane.

The spirally arranged chambers are often claw-shaped in a radius of 2 mm. Three whorls are most commonly seen. In all, chambers number up to 16 to 20. Maximum diameter of the shell including spines was 4 mm., length of the spine varies from ½ mm. to 1½ mm. Thickness of the shell varies from ½ mm. to 1 mm. Longest spine in a four-rayed shell is always opposite to the shortest. The spines are mostly conical attached to the shell at the broad end with fine canal system (seen under the microscope), which at their termination on the surface of the spine, give it a finely granulated ribbed appearance.

Remarks.—According to Narayanrao,[4] Baculogypsina which occurs in accompaniment of Pellatispira and Discocyclina, differs from the Pellatispira in having spinal canal-system and the absence of marginal cord. According to Mlle. Pfender, Pellatispira and Calcarina possess canal system. Pellatispira and Baculogypsina are correlated to the upper Eocene of Borneo.

S. R. Narayanrao[4] reports a similar form to *C. Calcitrapoides* (Photo Fig. 6, Pl. 2) but somehow names it "Baculogypsina". He does not give any species nor any description of the same except a few lines of its comparison with Pellatispira.

In Dr. Krantz's collection the slide *Calcarina calcitrapoides* from the Eocene beds of Holland resemble the sections in my slides in all respects. Zittel[6] gives a more ideal section for *Calcarina calcitrapoides* (Fig. 35); in *Elements de Palæontologie* (Fig. 8), Felix Bernard figures *Calcarina (Siderolina) calcitrapoides* LK (Mæstrichtien) which bears complete resemblance to specimens from Tadkeswar area.

External appearance gives the mistaken impression of a sponge (*e.g.*, Spongites, Astrophorous), or a Radiolaria but the absence of internal structure in both the latter clearly differentiates them from Calcarina.

Uptil now no text-book on Indian Geology refers to Calcarina to have occurred in the Surat Tertiaries due perhaps to its microscopic size which has made it unnoticed.

Occurrence.—The shell occurs in the calcareous clay overlying the compact Nummulitic limestone and accompanies Discocyclina. The forms are also associated with small Nummulites and Assilina although the genus Baculogypsina is, according to Narayanrao,[4] never found with them. The specimens were collected from the north-east of Tadkeswar and from the south-east near Bhankhurwari Nullan (Bhankhund Tadkeswar).

Age.—From the occurrence of the above two species in the upper parts of Nummulitic limestone series the particular horizon can be compared to the Yaw stage of Burma or lower Gaj Horizon of Sind.

Mr. S. R. Narayanrao bases his arguments in assigning upper Gaj Horizon (Burdigalian) to the Nummulitic limestone series, on the occurrence of Lepidocyclina, Baculogypsina and Pellatispira—the latter two being the same as Nuttal's Siderolites and Operculina from Kirthar series of Galla (six miles south of Tadkeswar) sent to Nuttal by Dr. T. W. Vaughan.

My thanks are due to Professor Dr. A. S. Kalapesi, for his kind guidance.

Bombay, HOMI R. BANA
September 25, 1944.

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1. Wynne, "Geology of Gujrat", *Geological Survey of India Records*, **1 & 2**. 2. Blanford, "W. India Tertiaries", *Ibid.*, **5, 6, 8 & 32**. 3. Nuttal, "Foraminifera of W. India", **1926, 59**. 4. Narayanrao, S. R., *Curr. Sci.*, **1939, 8**; **1940, 9**. 5. Dr. Carter, *Geology of Western Gujrat*. 6. Carl Von Zittel, *Text-Book of Palæontology*.

NOTE ON A *PETALONEMA* FROM NORTH INDIA

AN interesting blue-green alga closely resembling *Petalonema alatum* Berkley was collected in 1940 from near the Chakrata-Dehra Dun Road, at an altitude of 4,000-5,000 feet. This beautiful alga was found growing on small irrorated rocks. The alga occurred in the form of small expanded cushions of about ½-¾ of an inch thick and heavily impregnated with calcium carbonate. Inside the cushion, which in vertical sections shows zonations of growth (probably seasonal) the filaments are arranged more or less radially upwards. They vary in thickness, generally 40-90 μ broad, broader at the top and narrower towards the base. The cells are broader than long (8 μ long and 4 μ broad) in the younger parts and very much longer than broad in the older parts (10 μ long and 2 μ broad). Heterocysts are variable in form. False branches are generally single, but occasionally double. The branches bend upward and run parallel

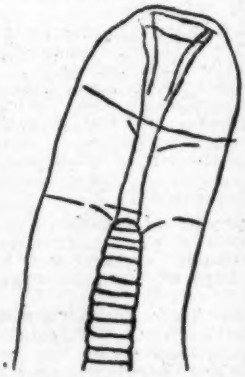

FIG. 1

FIG. 2

to the parent filament. The tip of the branch unlike in the type species is trumpet-shaped. Cells are constricted at the joints.

The trumpet-shaped tip of the filament (Figs. 1 and 2), the calcareous impregnation of the thallus and the radial arrangement of the filaments are among the chief features that distinguish the alga from the type species *P. alatum*. These points and the occurrence of the alga so far away from the type shows that it is probably a new variety of *P. alatum* for which the name *P. alatum* Berk. var. *indicum* var. nov. is suggested. As far as the writer is aware, the occurrence of either the type species or of this variety has not been reported from India previously. A fuller account of this alga is under preparation.

DIAGNOSIS

Petalonema alatum Berk. var. *indicum* var. nov.

Thallus, expanded cushions ½-¾ inch thick, impregnated with lime and showing zonations of growth (probably seasonal). Filaments arranged more or less radially upwards, varying in thickness (40-90 μ broad) broader at the top and narrower at the base, cells broader than long (8 μ × 4 μ) near the tip of the branch and gradually decreasing in breadth and increasing in length (10 μ × 2 μ) lower down, constricted at the joints. Branching false, single or double; branches running parallel to parent filament; branch tip trumpet-shaped; heterocysts present and variable in form.

Habitat: On irrorated rocks (calcareous).

Locality: Near Chakrata-Dehra Dun Road.

Department of Botany,
University of Lucknow, A. R. RAO.
July 30, 1944.

ON A NEW PLEROCERCOID FROM A SAND-FLY

THE accidental discovery of plerocercoids in the fatty tissue of a sand-fly*† during routine examination of insect smears for bacteria is so interesting and unusual as to be worth recording. The first bunch of plerocercoids observed by us was in a slide stained according to a method perfected by Dr. S. Mahdihassan for the demonstration of bacteria in insect tumours. Since the very minute size of the sparagana precluded any study in the living condition, the same procedure was adopted to locate these forms in other smears also prior to re-staining with Heidenhain's iron alum hæmatoxylin.

The insects are dissected under the binocular microscope and the fatty tissue of the abdomen, freed of the chitinous plates, is smeared on a well cleaned slide. While still wet, the slide is flooded with Bouin's fluid. After treatment for forty minutes with the fixative, the slide is washed successively with 50 and 70 per cent. alcohols and later rinsed well with tap water. It is then treated with a phosphate buffer of pH 7 for a few minutes and stained with a Giemsa solution prepared by adding 1 c.c. of the stock stain to every 25 c.c. of the buffer. The slide flooded with the stain is kept on a staining rack for an hour and after washing it well with tap water is treated for a few minutes with the buffer and then dried.

The dried stained smear presents a beautiful polychrome effect. The nuclei and the bacteria are of varying shades of pink, the ground cytoplasm blue and the cytoplasmic inclusions of mixed hues. The plerocercoids are lightly tinted pink. Those smears showing the sparagana were later stained with iron hæmatoxylin and mounted under a coverslip.

Two different stages of development were observed in the preparations. The first which appears to be an earlier stage occurs as a skein of threads. They are so thin that when lying close together in a row, ten of them

occupy less than 1·5 μ in width. No segmentation or a differentiated scolex could be observed in these tangled masses. However, they appear to branch, the branches and the main stems getting lost in the meshes of the skein.

The second stage shows distinct segmentation and we have a preparation of a clump of these plerocercoids in a mass of tissue showing not only branching but also a few scolices. The club-shaped scolex measures 10 to 20 μ

in length and this with the neck region following immediately appear deep blue, while the other regions are stained in varying shades of blue. The maximum width of the scolex (Fig. 1 H) varies from 4 to 7 μ while that of the neck varies from 1 to 2 μ. No bothridial grooves were observed in any of the specimens examined. In Fig. 2 is shown the mode of branching. The main stem as well as the buds show segmentation, but the segments themselves are of variable size, ranging from 3 to 5 μ in length and 3 to 6 μ in width. In Giemsa stained slides the central core of parenchyma is stained more deeply than that of the cortical region.

The presence of distinct segmentation raises the question whether the specimens described above could be considered larval stages at all? The absence of any indication of developing reproductive organs and the occurrence of the specimen itself in the fatty tissue of a sand-fly leads us to believe that it is only a peculiar larval stage of some Diphyllobothrid. Presence of segmentation in larvæ does not appear to be very peculiar for, Meggit[1] mentions that larvæ of *Schistocephalus* and *Urocystidium* show segmentation.

This is perhaps, the first record of a Sparaganum from insects. The previous records are all from fishes and other higher vertebrates and the only form showing branching is *Sparaganum proliferum* (Ijima, 1905) reported from the subcutaneous cysts of man (Ijima,[2] Yoshida[3]). The form described by us though apparently resembling *S. proliferum* differs from it (1) in its occurrence in the fatty tissue of a sand-fly and (2) by its possession of distinct segmentation. Precedent would probably justify the creation of a new genus to receive the above form, but we refrain from doing so because helminthological literature is already cluttered up with ill-defined species, which make identification a matter of considerable difficulty.

Hyderabad (Dn.), *October* 5, 1944. M. K. SUBRAMANIAM.
MOHAN BABU NAIDU.

1. Meggit, F. J., *The Cestodes of Mammals*, London, 1924. 2. Ijima I., *J. Coll. Sci., Imp. Univ., Tokyo*, 1905, **20**, 1–7. 3. Yoshida, S., *Parasitol.*, 1914, **7**, 219–225.

* We are very thankful to the Vice-Chancellor of the Osmania University for permission to work in Dr. Mahdihassan's laboratory; to Dr. Mahdihassan for his active interest and to Prof. B. K. Das for loan of books and journals. One of us (M. K. S.) would also like to thank Messrs. The Biochemical and Synthetic Products Ltd. for their encouragement.

† This sand-fly commonly occurs in marshy places in Hyderabad and belongs to the family Psychodidæ. A permanent mount of a bunch of these plerocercoids together with a few specimens of the sand-fly will shortly be deposited in the Indian Museum.

SOME OBSERVATIONS ON *MYCOBACTERIUM LEPRAE*

Is the degree of granularity of *Mycobacterium lepræ* constant in the various nodules? Does it rise and wane? Does it attain a peak in the oldest nodules? These are questions for which we have as yet no definite answer. In the light of Hoffmann[1] and Manalang's[2] suggestion that under treatment the rod-like bacilli become granular the above questions assume an added significance. Hansen's[3] original description itself contains records of rods and granules and many who claim to have cultured these bacilli (Lowenstein,[4] Salle,[5] Ota and Sato[6]) describe rods, "seed rows" or "string of pearls" and granules. Hoffmann considers that Hansen's bacillus produces "in its evolutionary cycle great numbers of granular forms which are found both within the bacilli and as free lying bodies". In the case of the tubercle bacillus Kahn and Nonidez[7] conclude that granule formation "is a type of segmentation rather than direct fission in which the rate of segmentation surpasses the ability of the elements to elongate". Marchoux[8] states that like Hansen's bacillus "the Stefansky bacillus may break up into granules". If the suggestion that the formation of granules is an essential phase in the life-cycle is accepted, then, how are we to distinguish these from

those formed by degeneration or disintegration as a result of treatment? It will be seen, therefore, how necessary it is to have an idea of the picture presented by young and old nodules in one and the same patient.

Very recently through the kindness of Dr. A. Shama Rao, Leprosy Officer to the Government of Hyderabad, I obtained smears and biopsy specimens from a lepromatous case which presented some peculiar features which are recorded below. Dr. Shama Rao's diagnosis is as follows:—"A. K., aged 30. Lepromatous case under treatment for the last ten years. He was an L_1 case but has now become L_2. He has nodules on the ears some of which are small and others big. A few are scattered on the body also. The face is infiltrated. There is no deformity of hands and feet and neural and acroteric symptoms are absent." On Sunday, 18-6-1944, a large nodule from the lobe of the right ear was removed and after making a few smears was fixed in Regaud's fluid. Again on Wednesday, 21-6-1944, a small nodule from the left ear was clipped and a few smears made. All the smears were stained in Ziehl-Neelsen and counterstained with Loffler's alkaline methylene blue.

In the smears made on Sunday from the large nodule, the following picture was observed. The bacilli in the globi are irregularly scattered, and those at the periphery have often a concentric arrangement. Though in most of the globi no stainable content other than the bacilli occur, yet in a few large ones where the clumped masses of bacilli occupy half or three-fourths the area of the globi only, the bacteria-free portion is stained by methylene blue and present a granular appearance. The walls of the globi are well defined and nuclei may be seen sticking to the walls. But whether these nuclei belong to the globi could not be made out from the smears. The smallest globi are less than 7 μ in size and are generally spherical. In the smear many empty spaces comparable to globi but devoid of bacilli could be seen. Since the outer limiting membrane of these clear spaces appears to be incomplete it seems as if these are globi which have got ruptured during the smearing process.

The bacilli in these globi are short rods, the longest of which is 5 μ long. But these long ones are rare as also granular forms. Very few—one in each field—of the long rods showed any beaded appearance. In one or two in each field there was just the suggestion of development of a bead at one end. In some regions the alignment of the short rods suggest as if they have separated from a beaded chain.

Typical "cigar packs" without any limiting membrane could be observed in various regions of the smear. These are always composed of long bacilli. From comparison with larger bundles all these long packs of bacilli could be arranged in a linear series. Single long bacilli lying free have lightly stained halos which do not completely envelope them. When two long rod-like bacilli lie side by side, they appear enclosed by the halo. In some globi which present the typical 'cigar pack' arrangement, one can see gradations from long rods 7-8 μ long with a very faint suggestion of beading, to the smallest granules. Rarely single rods taper to the ends, and sometimes a beaded rod alone may be seen in a clear vacuole.

In the smallest globi measuring 5-6 μ the short rods have a peculiar arrangement. They form a regular row at the periphery, with only one or two lying in the middle. Denney[9] describes longitudinal splitting and branching but no such forms were found in the smear.

Except in the larger globi, where the outline of the globus stains deeper with methylene blue suggesting a definite membrane, in the smaller forms there is no such uniform differential staining. Often bacilli observed projecting into the blue stained cytoplasmic area suggest that the membrane is a later formation. Only careful study of serial sections would clarify this question. Irrespective of the size of the globi, the bacilli seen in them differ in shape. Some are packed with small rods and others with longer ones. The majority of course belong to the former category and only one in fifty to the latter. One in every hundred of these globi show arrangement of short rods suggestive of the fact that they may have belonged to chains. In the others, the arrangement is very irregular.

In the smaller nodule from which the smear was made on Wednesday the appearance of the bacilli is entirely different. About 90 per cent. in any field are long beaded ones and the other 10 per cent. being composed of long rods without beads, short rods and granules. Bacilli possessing from 2 to 8 beads could be observed in any field and even the alignment of the short rods and granules suggest as if they have just separated from chains. This impression is accentuated by the fact that rods with variable number of beads and free granules or small rods aligned in the same longitudinal plane could be seen in any field. Most of the globi are packed with these "seed rows" which if carelessly stained give the impression of a clump of grains.

It would be seen from the above description that though the degree of granularity may be said to be constant for a single nodule it is not constant for all nodules in the same patient and neither does it reach a peak in the oldest nodule. One is led to agree with Cowdry[10] that "though a single biopsy specimen may exhibit marked granularity, this may or may not be a favourable sign". When we consider that the patient has been under treatment for ten years and when different nodules give different pictures, the suggestion that under treatment the rod-like bacilli become segmented and granular and that such an appearance indicates a favourable prognosis appears to be of questionable validity.

I am very thankful to the Vice-Chancellor of the Osmania University for permission to work in Dr. S. Mahdihassan's laboratory, and to Dr. Mahdihassan and Messrs. The Biochemical

and Synthetic Products, Ltd., for their encouragement.

Hyderabad (Dn.), M. K. SUBRAMANIAM.
July 21, 1944.

1. Hoffmann, W. H., *Internat. J. Leprosy*, **1933, 1,** 149–58. 2. Manalang, J., *Monthly Bull. Bur. of Health, Manila*, **1937, 17,** 3–17, 47–54. 3. Hansen, A., *Internat. J. Leprosy*, **1934, 2,** 476. 4. Lowenstein, E., *Ibid.*, **1935, 3,** 43–47. 5. Salle, A. J., *J. Infect. Dis.*, **1934, 54,** 347. 6. Ota M., and Sato, S., *Internat. J. Leprosy*, **1934, 2,** 175–93. 7. Kahn, M. C., and Nonidez, J. F., *Amer. Rev. Tuber.*, **1936, 34,** 361–82. 8. Marchoux, E., *Internat. J. Leprosy*, **1934, 2,** 89. 9. Denney, O. E., *Ibid.*, **1934, 2,** 275–78. 10. Cowdry, E. V., *Puerto Rico J. of Pub. Health and Trop. Med.*, **1938**, pp. 95–117.

STORAGE OF POTATOES

IN your May issue (pp. 133-134) Dr. Khan A. Rahman described a method of preventing damage to stored potatoes by covering them with various materials, such as sand, chopped lantana, grass or soapnut leaves, pine needles, saw-dust or *bhusa*. The author claims that a problem which had baffled entomologists in India since 1907, yielded to his investigations and in the very first year of his work—in fact within three months, July-September—he obtained results which he describes "so striking and encouraging", that he has shown considerable anxiety to communicate his discovery to the Indian scientists. A moment's reflection, however, will show that there is nothing very extraordinary about these results. Briefly described the experiment was that Dr. Rahman placed 43 maunds of potatoes in a room, in 56 lots. Of these he covered 48 lots with various materials and left 8 lots, weighing a little less than 5 maunds, uncovered, *i.e.*, exposed. He then distributed 8 maunds of heavily infested potatoes, uniformly in the room, *i.e.*, introduced the pest. The only thing that could have happened was that the moths would lay eggs on the exposed food material of the caterpillars. And this is exactly what they did. This inevitable behaviour of moths hardly necessitated any experimental proof.

The difference in the percentage of attack between different "treatments" are insignificant. The striking differences between the control and experimental potatoes, simply show that the attack got concentrated or localised, on the exposed potatoes, and these, therefore, showed unusually high percentage of infestation. Unfortunately the author cannot claim this as a striking contribution to the solution of this problem. The practice of covering potatoes with sand is an old one and a very common one. Storage under sand has also shown variable results under different conditions. The problem of storing potato safe from potato moths and fungus diseases is not so simple as the article has made it out to be. On account of the intricate nature of the problem its detailed study has been undertaken in a scheme of the Imperial Council of Agricultural Research at Sabour.

In the experiments described by Dr. Khan A. Rahman the control was not designed scientifically and this has led the author to fallacious conclusions.

Department of Agriculture,
Bihar, Sabour, M. L. BHATIA.
August 28, 1944.

NOTE ON THE SWARMING OF THE PLANKTONIC ALGÆ *TRICHODESMIUM ERYTHRAEUM* IN THE PAMBAN AREA AND ITS EFFECT ON THE FAUNA

ON page 404 of *Current Science*, Vol. 4, No. 10, dated October 1942, Mr. P. I. Chacko had reported an unusual phenomena of mortality of marine fauna including 750 Holothurians and 250 fishes, which occurred in the tide pool on the southern side of Krusadai Island in May 1942. He had attributed the cause to the fact that "the fishes were slowly asphyxiated by *Trichodesmium* obstruction before being washed ashore by the high tide".

A similar phenomenon was noticed this year on the southern coast of Pamban in the same month, when the following fishes and crabs were washed ashore dead: (1) *Gerres filamentosus*, (2) *G. abbreviatus*, (3) *Chanos chanos*, (4) *Mugil* spp., (5) *Saurus indicus*, (6) *Platycephalus insidiator*, (7) *Therapon jarbua*, (8) *Sphyraena obtusata*, (9) *Lutjanus lioglossus*, (10) *Neptunus* spp., (11) *Gelasimus* spp.

Besides confirming the cause referred to by Mr. Chacko for the mortality, our recent observations showed that the mortality was also due to the putrefaction and pollution caused by the dead algæ. From 22-5-1944 onwards there was bright sunshine which was responsible for the swarming of the algæ in large patches by the acceleration of the photo-synthetic activity. On 25-5-44 when it was cloudy, the absence of sunlight, the thick layer of floating algæ and increase in temperature the water had caused the death of the algæ and polluted the waters causing the liberation of the offensive smell. So long as the algæ was in living condition, no casualty was observed. On 27-5-44 with the slight showers the dead algæ had settled down to the bottom and the "balance" in the water was restored. The clogging of the gills with the consequent asphyxiation and the related hydrological disturbances should have been supplemental factors for the heavy mortality of fishes.*

Krusadai Biological Station,
Gulf of Manaar, K. CHIDAMBARAM.
August 15, 1944. M. MUKUNDAN UNNY.

* With the kind permission of the Director of Industries and Commerce, Madras.

REVIEWS

Clowes and Coleman's Quantitative Analysis. (Fifteenth Edition.) Edited and Revised by Dr. Julius Grant. (J. and A. Churchill Ltd., London), 1944. Pp. viii + 557. Price 21/-.

This new edition of the well-known and popular text-book should be most welcome not only to all students of chemistry in the universities but also to some professional chemists who undertake a variety of miscellaneous analytical work. The material is presented in eight parts which describe respectively (1) General processes including physical determinations and analytical operations, (2) simple gravimetric determinations, (3) volumetric analysis, (4) miscellaneous methods of analysis, (5) applied quantitative analysis including (a) water analysis, (b) analysis of foodstuffs including beer, wines and spirits, sugar and tea, (c) examination of oils, fats and waxes, (6) general organic analysis, (7) gas analysis. The last part gives a most useful set of reference tables which include the results of typical analysis of materials of technical importance and tables of useful constants.

The scope of the book would certainly appear to be too large and ambitious for its size, but the author has succeeded in his attempt to present the entire material in a concise and clear manner. It is a pity, however, that there are some errors and misprints such as (1) "Without this reagent" for "with this reagent" in line 37 on p. 185; (2) "$6F^{++}$" for "$6Fe^{++}$" on p. 285; (3) $Zn(NH_4)PO_4$ for $Mn(NH_4)PO_4$ on p. 75; (4) "potassium oxide" for "potassium iodide" in line 12, p. 288; (5) "potassium nitrate" for "potassium nitrite" in line 8, p. 73; (6) Na_2CrO_8 for Na_2CrO_4 in line 3 on p. 259.

The reviewer considers that the author has succeeded in producing a book to which "the student will turn for a reliable cross-section not only of the standard methods of analytical chemistry, but also of the modern trends of the subject". The book can be very heartily recommended for careful study by all students of chemistry in the University classes.

K. R. K.

The Application of Radiant Heat to Metal Finishing—A Critical Survey of the Infra-red Process for the Stoving of Paints and Enamels. By J. H. Nelson and H. Silman. (Chapman and Hall, London), 1944. Pp. vi + 79. Price 8/6.

Heating by radiation has been extensively used in industry, employing both gas and electricity as the heating media; but so far as paint baking in the metal finishing plant and processes are concerned, recent developments have been chiefly carried out by the electrical industries, making use of tungsten filament bulbs as source of radiation. The baking of enamels, particularly those of the synthetic type, is brought about by a polymerisation process which takes place at a temperature usually of the order of 250-350° F. For rapid baking it is important to bring the temperature up as quickly as possible and it is here that the advantages of heating by radiation become evident, as it is possible to convey a great deal of energy to the surface being heated with great rapidity and ease. Thus it is possible to cut down the drying time to a fifth or less of the time taken in the usual type of gas-heated convection ovens. This method of heating is more spectacularly referred to as "the infra-red process", although the precise nature of radiation has little or no influence on the phenomenon of paint drying.

The book under review deals with the fundamental principles of radiation plant design and since it is written mainly "from the standpoint of the user who is concerned with the installation of efficient metal-finishing plant", the last two chapters are devoted to paint formulation to meet the special characteristics of radiant heat process and to the fields of application of radiant heating.

When a receiver begins to rise in temperature, it starts also to lose heat by convection to the surrounding air. Thus although the air does not stop the radiant energy reaching the receiver, it will aid a very rapid loss of heat if due care is not taken, and thereby limit the rise of temperature. From considerations on these lines, it can be shown that radiant heating can best be applied to articles having relatively small heat capacity for their area, and requiring very rapid heating to a temperature not greatly in excess of their surroundings. Articles needing heating to a temperature very much above the surroundings are not suitable, unless radiators capable of large outputs are available. Radiant heating electric lamps up to 1000 watts, have been developed in U.S.A., the latest development being the "sealed beam" unit, with the bulb, reflector, and front dispersion lens all combined in one unit, with bi-post filament leads. More recently gas-fired radiant heating ovens have been developed in England, which combine simplicity and robustness with the advantage of very much higher energy densities. Chapters II to V deal with the principles of heat transfer and the design and construction of radiators, reflectors and ovens.

"It can be said with little fear of contradiction that for the baking of paints and enamels on most sheet-metal articles, the purely convection type of oven is obsolescent, though certain uses may prove economic owing to peculiarities of design. The whole field of industrial heating would seem to be open to radiant energy, though in a very large number of cases the simultaneous effects of conduction and convection will still be of equal importance". The book gives a balanced account of the present stage of development, and should be of great value to manufacturers and users alike.

M. A. G. RAU.

Industrial Planning for Post-War Mysore. By B. S. Narayana Rao, Civil Engineer, Tumkur, 1944. Pp. vi + 16. Price 8 As.

This apparently hastily printed and published brochure of 16 pages (4" × 6" size), with too many spelling and grammatical mistakes, could well be a carefully revised contribution to one of the various scientific and technical journals published in Mysore or outside it in India. It deals all too briefly with several local problems of transport, water supply, fuel, research and finance, and the possible distribution of future industrial undertakings in the State.

M. A. G.

The Indian Cotton Textile Industry (1943 Annual). Edited by Mr. M. P. Gandhi. (Published by Gandhi & Co., Bombay). Pp. 150. Price Rs. 4-4-0.

Mr. M. P. Gandhi deserves to be congratulated for bringing forth the Indian Cotton Textile Industry 1943 Annual with several improvements over its predecessors in spite of the cramping economies imposed by the war. The volume contains valuable and interesting information and statistical data relating to the developments of the industry from all aspects. In discussing the progress of the industry, the author pointedly draws the reader's attention to the post-war prospects and problems facing this premier national industry employing at present no less than 5 lakhs of operatives, over 5,000 University men, with a capital of 49 crores of rupees. A considerable portion of the book is devoted to chronicling the major events during 1943 in the sphere of textiles—particularly the various control orders affecting the industry, the working of the Textile Control Board, introduction of standard cloth, comprehensive price control and marketing of yarn and cloth, etc.,—all of which makes interesting and useful reading.

The book concludes with three appendices. The first one deals with cotton, its cultivation, import and export and the problems India has to face in the matter of short-stapled cotton in the light of the changing conditions in the industry both at home and abroad; the second with the handloom industry and the last gives a list of cotton mills in India. The chapter on the handloom industry is indeed a very informative and thoughtful contribution. The author has made copious extracts from the report of 'Fact Finding Committee (Handloom Mills)', appointed by the Government of India, whose report was published in 1943. With a wealth of revealing data, he has exhaustively discussed the various factors that have affected this age-old but grossly neglected industry and the remedial measures necessary to put it on a sound footing. Handloom industry is, next to agriculture, the largest single industry in the country employing nearly 2½ million men and maintains a population of about 10 millions. Although it may be said to enjoy a short spell of prosperity owing probably to the scarcity of cloth and the several control measures instituted by Government, the author has rightly stressed the Enquiry Committee's recommendation that apart from Government help and co-operative effort, it is necessary to run the industry on businesslike and commercial basis with the active association of businessmen of proved ability and character if it is to flourish and thereby help to revitalize rural life.

There is a short reference to the various minor industries ancillary to the Textile Industry—concerned in the manufacture of healds and reeds, bobbins, shuttles, starches, etc. Mr. Gandhi would do well to create greater consciousness through his publication with regard to the need for stabilising these industries and establishing heavier industries for manufacture of textile machinery.

B. G. R.

CARNEGIE INSTITUTE OF WASHINGTON*

THE travails of war have undoubtedly had far-reaching repercussions on normal life in every land, but it is refreshing to note that in keeping with American tradition, the march of time does not find scientific progress left behind. The publication under review, quite in keeping with national needs in times like the present, relates to the record of researches directed toward the prosecution of war.

The division of plant biology, headed by the physiologist, Spoehr, engaged itself in problems of ultimate utilitarian value. Starting on the premise that plants are the sources of basic food upon which mankind has to live, new avenues are sought for in this direction. In the past, the manufacture of food in the green leaves of land plants has been studied, and to-date, our knowledge of this complex process is fairly clear. Having in view other less-known plant-forms and materials which could likewise be used as probable sources of food, row somewhat naturally, research has been directed to the study of photosynthesis in members of plankton-flora, diatoms, brown and red algæ, dinoflagellates, yellow-green and the blue-green algæ, inclusive of one-celled coloo-oil-yielding regions. A study of photosynthe-nail algæ. Fossil diatoms have given clues to sis in living ones reproducing under experimental conditions such as those that might have prevailed in former geological ages, throws light on geological formations of the earth.

The classical work of Warburg and Negelein on the one-celled green alga, *Chlorella*, has yielded great many secrets of photosynthesis before. Adopting like technique, twenty species of algæ, diatoms, less abundant Cryptophyceæ, dinoflagellates and blue-greens have been isolated, by micromethods, cultured, and details of photosynthesis studied in these.

By chromatographic adsorption analysis, pigments of Bacillarieæ, Xanthophyceæ, Dinophyceæ, Cryptophyceæ, members of Chlorophyceæ and Phæophyceæ, have been isolated, analysed

* Carnegie Institute of Washington, Year-Book No. 42, 1942–43. (Carnegie Institute of Washington, Washington, D.C.), 1944. Pp. 208.

and chemically studied; likewise, the influence of various factors on photosynthesis has been studied by modern methods. Over 24 plant pigments have been studied, and the majority of components of pigments of the green algæ appear to be identical with those of the higher plants, whereas pigments now studied in members of various groups cited above show wide structural and distributional differences. Based on chemical affinity between several of these pigments, a phylogenetic grouping is attempted.

The effect of various factors, of chemicals like potassium, nitrogen, phosphorus, and of light, on cultured *Chlorella pyrenoidea*, have been studied, and as an overall measure of synthetic activity, instead of assimilatory coefficient, R-values (i.e., degree of reduction of Co_2) have been adopted. The authors claim that these R-values can be experimentally enhanced to 38-50 times the normal in this alga, whereas in green leaves it is not more than 30-40. This means, the food output can be increased. In this way, the experimental study of the modifiability of photosynthesis in pure cultures of these forms opens up new avenues of food sources, and will also lead to a more comprehensive understanding of photosynthesis in the entire plant kingdom than is available now. In that β-Carotene, a component of green pigment, is the precursor of vitamin A, these forms were studied for their sources of vitamin A and vitamin C and the results, tentative now, appear to be hopeful. No literature list accompanies these chapters.

EXPERIMENTAL TAXONOMY

The ever-absorbing question of what is a species, its position as a unit in Biosystematics, its resolution by modern Cyto-genetic methods, the formation of various evolutionary patterns in normal sequence, the role of amphidiploidy in speciation and the ecological adaptability of these in geographic distribution—these are some of the engaging problems with which the section of experimental taxonomy occupied itself within the past year. Amphidiploidy in Madiinæ has been studied and agriculturally useful amphidiploids in *Phleum*, *Poa* and *Agropyron* have been raised.

PALÆOBOTANY (DR. CHANEY)

The discovery of fossil Cactaceæ and other succulents in mid-Eocene throws light on the origin of arid climate in Pliocene and this is of interest in the reconstruction of topography of early geological ages. A select literature list is appended.

DEPARTMENT OF GENETICS

The fact that the war effort of the nation did not make big demands on this department has not by one whit diminished the pursuit of pure research.

Warmke and Davidson continued their investigation on the cytology and breeding behaviour of the *Russian Dandelion*. Anatomical studies of the root revealed a definite and regular increase in latex percentage with increase in distance from the crown. The part of the root used in sampling was, therefore, found to be of great importance for breeding purpose. Artificially induced tetraploids showed the usual complex of gigas characters and efforts are being made to see if increase in root-size is accompanied by increase in rubber content.

The colossal expansion of industry in wartime has brought in its train new sufferings to humanity—one of which is the serious injury to the human eye as a result of constant exposure to ultra-violet radiation. Working on tissue-cultures of neuroblast cells of the grasshopper *Chortophaga viridifasciata*, Kaufmann and Hollaender have found that exposure to ultra-violet radiation of wave-length 2573 Å at an intensity of about 3000 ergs per square cm. per second for periods of only 5-10 minutes will arrest cell division for a considerable length of time. Apparently dividing cells are extremely sensitive to wave-length 2573 Å which appears to cause a blocking of cells in prophase. Ultra-violet radiation differs strikingly from the X-ray effect in the absence of a compensatory period after recovery.

Hollaender, Dmeerec and Sansome have continued irradiation experiments with the fungus *Neurospora*. The frequency of X-ray induced mutation increases approximately in proportion to the dosage even when high dosages are employed. Treatment with 126,000 roentgens induced about 75 per cent. mutations which is the highest induced mutation rate on record. It is significant that 2650 Å, which is absorbed by nucleic acid to a high degree is the wavelength most effective in producing mutations.

Fano has shown interesting conclusions as a result of his experiments in which sperm of *Drosophila* was treated with neutrons. The frequency of association of lethals and rearrangements appear to be much higher in neutron-treated than in any other material. This is in keeping with the evidence that neutrons as a rule produce fewer gene mutations and more chromosomal rearrangements than energetically similar doses of X-rays.

Through a study of the data on complex rearrangements induced by X-rays Fano concludes that the healing of potential breaks is influenced by mechanical stress that may be exerted through movement of the chromosomes. Potential breaks induced on exposure to X-radiation in the mature sperm of *Drosophila* are not utilised in the formation of new chromosomal arrangements until after the sperm has entered the egg. Since irradiated males may be kept for several days before copulation, a considerable period of time is available between radiation and fertilisation for efforts to alter experimentally the recombination capacity of broken ends of the sperm chromosomes. Such efforts involved exposure of the inseminated females to incubator temperatures of either 18° or 28° C., or to the heating effects of the near infra-red rays. Data assembled indicates that both the near infra-red and 28° temperature give percentages of altered sperms. It would seem that higher temperatures facilitate those chromosome movements which lead to the production of contacts between the broken ends of the chromosomes.

In co-operation with Marinelli, Fano has provided a new calculation to the hypothesis that large ion-clusters are responsible for X-ray induced chromosomal breakage. This super-

sedes the old idea that the absence of any wave-length effect in the genetic action of X-rays should be interpreted to mean that this action is produced by single ionisations or small ion-clusters, such as commonly occur along the paths of photo- or compton-electrons in tissue. Lea and Catcheside (Cambridge-England) used the same argument and calculated that clusters of approximately 20 ionisations ought to be the most effective in breaking chromosomes. Dr. Fano goes further and has calculated that 1r of X-rays produces approxumately 0·1n clusters per cubic micron.

Mc Clintock has continued her investigations on the breakage and fusion of *Maize* chromosomes. She has evidence which suggests that the capacity for fusion of a recently broken end of a chromosome will be lost if this chromosome undergoes a division cycle before fusion with another such end has occurred. In the course of an attempt to determine the amount of crossing over that may occur within small segments, Mc Clintock found that relatively large amount of crossing over may occur between the loci of two mutants that are physically close to each other on the chromosome.

However hampered by conditions of war, the uniform excellence of researches in 1942-43, and the direction of these to new channels mark a distinctive feature of the work of this mighty institution. In common with former volumes, the get-up is good and presentation perfect.

K. V. S.

COUNCIL OF RESEARCH, UNIVERSITY OF TRAVANCORE

THE Thirteenth Report of the Vice-Chairman (Dr. K. L. Moudgill), Council of Research, University of Travancore, presented to a recent meeting of the Council, is, in the main, a factual summary of the progress of the several research schemes inaugurated under the auspices of the Council. It is not easy even to enumerate within the compass of a brief note the several problems which are under investigation. They cover an extremely wide range from the utilisation of the bitterns of the salt pans to the production of Agar-Agar, and of Titanium white from Ilmenite on the one hand, to a study of Teak defoliators, Gumkini, preparation of vaccines and Development of Fisheries on the other. The Laboratories of the Central Research Institute comprise of Public Health, Applied Biology, Applied Chemistry, Marine Biology and Observatory Sections. The work done in each of these sections is briefly indicated. It is obvious from even these necessarily brief summaries in this Report, that the Council has set before itself an ambitious programme planned with vision and enterprise. The very problems which have been given priority are indicative that Travancore, no less than other progressive communities, has not escaped the ferment which compels the attention of all thoughtful men to tomorrow and the brave new world to be brought into being after the war.

One is naturally tempted to project mentally some at least of these research schemes on to the larger canvas of the all-India research institutions and organisations. The retting of coconut work is a problem in which Travancore is not the only unit interested. Paddy problems are being tackled by the I.C.A.R. on a wider basis. Again, work on the collection and interpretation of meteorological data to serve even purely local needs could easily be made to be much more useful in conjunction with the all-India data. Conversely, the results or even the biproducts of the research carried out in Travancore might well prove to be of significant importance to people outside the State. An illustration, it makes sad reading in the Report, is that although the production of Agar-Agar was successfully initiated and developed by the Council to cover local needs, Travancore could supply but 55 lbs. against a demand of 150 lbs. by the Public Health Department of stricken Bengal. It must be added, however, that the Council have taken steps to avoid such a contingency in future.

It would be of interest and use to the other States and Provinces if the expenditure incurred by the Travancore Council of Research for investigations on so wide a front were given in this Report.

Dr. Moudgill's Report concludes with some very apposite observations on the provision of research and technical personnel to adequately cover the needs of post-war India. He takes note of the dismal possibility that even the facilities for training and research might have to be rationed on a quota basis—so great would be the disparity between supply and demand not only in India but also in Europe and America. He raises the very grave issue whether "formal courses leading to diplomas and degrees have their limitations" in training a technician, "no matter what his status—operative, foreman or leader". He undisguisedly frowns on "our present plethora of publicity, it has become the fashion for people to talk of schemes of research they sponsor and to judge the worth of people by the number of schemes of research they sponsor and the number of papers which they publish", and urges "that we should plan attunement of our personnel to our needs of the future". The wish that this part of the Report is brought to the notice of the much wider audience than the one Dr. Moudgill actually addressed does not imply that one necessarily agrees with all the premises and conclusions of the author. Dr. Moudgill concludes with quoting a Chinese proverb, "If you are planning for one year, grow paddy; if you are planning for fifteen years, grow trees; but if you are planning for a hundred years, grow men". *That* needed being said—*and* heard by all the planners.

SCIENCE NOTES AND NEWS

Writing in *The Times* under date 20th September 1944, Prof. A. V. Hill urges that one of the most pressing requirements of Indian Science, frankly recognised in India, will be of opportunities for higher study and research abroad for abler young people, future scientific leaders, who have been piling up during the war period. The same need exists in medicine, engineering, industry and many other fields. "In trying to meet it", Professor Hill adds, "we must help all we can, but it will not be easy to find spare places in our universities, hospitals and research establishments at a time when all our own young people will be returning from the war and I think we can rightly ask that, those who come here from India in the next few years of exigency, should be carefully selected before they start. Moreover, many of the ablest and most suitable people will be unable to bear the expense. It will be worth while for India to provide them with travelling bursaries or scholarships; the sterling balance is now so large that any possible expenditure of this kind will be completely insignificant, and it is difficult to imagine any better way of spending it."

Mr. John Sargent, Educational Adviser to the Central Advisory Board of Education of the Government of India, who is returning to India in October following a six weeks tour of American educational institutions, said in an interview to American journalists, that 2,000,000 teachers will be trained for post-war education in India and that extensive plans are now being made to provide many of these with special technological training in American colleges and universities.

"Our programme for post-war education in India has two great objectives—the solution of immediate practical problems and familiarizing our teachers with the culture, science and national character of countries other than our own. In both fields, we believe a period of education in the United States must play an important part."

Mr. Sargent listed the following as among the branches of technical study and research planned for Indian students who will be sent to the United States: Preservation of food, including freezing, canning and dehydration; distribution of food and other vital supplies; irrigation and hydro-electrics; aeronautical engineering and transportation. "My recent visit to great centres of technical training and research in the United States have further demonstrated the fact that America leads the world in these fields. We now are setting up a plan whereby Indian students with proper educational background and knowledge of English will be encouraged to take advantage of what the United States offers for the future of India.

"Our Central Advisory Board of Education purposes to correct the situation of the past whereby Indian students frequently lost much of the value of their study in the United States because they had not received the proper advice and guidance in advance. There is no record of an Indian student ever encountering an obstacle to his desire to study in the Unied States. Indeed, some Americans have expressed alarm at the extreme views of some of the young men and women we have sent over. We do not hope to insure that students who come to America not only are supplied with sufficient funds so that they will not be economically handicapped but that they are also possessed of good health and suitable educational background for the advanced work which they will undertake."

Mr. Sargent pointed out that since the beginning of the war there has accumulated in India a vast number of young men and women whose plans for overseas study had to be abandoned temporarily. In the post-war era—perhaps even before—it is expected the majority of these will leave India for study abroad. "We are most optimistic as regards prospects of our Executive Council granting approval of the plan we have prepared", Mr. Sargent concluded, "It appears they are agreed that India's great push forward after the war must be started by technicians. These technicians, we hope, will receive many of their ideas and much of their training either in the United States or from teachers who have been trained in the United States."

After receiving the medal of the Society of Chemical Industry at the Royal Institution on Friday, the 13th instant, Prof. A. V. Hill referred to his recent five months' visit to India and said the greatest need was for fuller use of science and scientific method, for this would have considerable effect on poverty from which India suffered. The first of India's scientific needs was to strengthen and expand education and research in biological sciences, in medicine and its associate subjects, in physiology and biochemistry, in genetics and all applications of biology to fisheries, agriculture, public health, pest control, animal and plant diseases and forestry. There must also be better facilities for teaching and research in physics, chemistry, metallurgy and engineering without which industrial prosperity could not be attained.

Sir Nelson Johnson, Director of the Meteorological Organisation in England, has arrived in India to study the working of the Meteorological Department of the Government of India and to suggest ways and means for its improvement and increased efficiency. Impending war operations in the Burma front demand increase in standard and efficiency and to attain this, the Government of India is stated to have felt the need for expert advice.

The Government of India have constituted the following Committee to examine the ques-

tion of Indian Fisheries with a view to increasing production of fish in India: The personnel includes Mr. Fazul Ibrahim Rahimtoola, C.I.E., (*Chairman*); the Hon. Nawab Khursheid Ali Khan, M.B.E., Member, Council of State; the Director of Industries and Commerce, Madras; Mr. B. K. Dubash, of the International Fishing and Trading Co., Bombay; Mr. A. Karmally of Bombay; Mr. Jyotish Chandra Biswas of Calcutta; Pir Mohamed Haji Juman, Fish Merchant, Karachi; Dr. C. C. John of Trivandrum; Mr. S. Najmul Hassan, M.L.A., Bihar, Patna; Dr. Baini Prashad, Fisheries Development Adviser to the Government of India (*Secretary*).

A ten-year plan to increase coconut production (and thus stimulate the production of copra and coconut oil), by better treatment and manuring of plantations, is suggested in a report on the marketing of coconuts and coconut products by the Central Agricultural Marketing Department, Government of India. The administration of the plan, it is recommended, should be entrusted to an All-India Central Coconut Committee, which may give loans at cheap rates for manures and other improvements. The area under coconuts in India is about 1·5 million acres, producing annually about 3,000 million nuts. This, according to the Report, can be increased by intercultivation and manuring on a wide scale.

A meeting of the Plastics Research Committee of the Council of Scientific and Industrial Research was held in Bangalore on the 17th and 18th September 1944, Sir J. C. Ghosh presiding. The Committee recommended that every attempt should be made to manufacture in India the essential raw materials for the development of Plastics industry; phenol urea, phthalic anhydride, glycerine, furfurol, formaldehyde, poly-hydric alcohols, acetone, ethyl, butyl and amyl acetates, cellulose esters and ethers, constitute some of the principal ingredients. In the field of Plastics of natural origin, they consider that the following materials need closer investigation. Shellac, animal and vegetable proteins, rosins, vegetable oils, industrial wastes like horn waste, bagasse, coffee beans, seed-cakes, etc., and lignin.

The Committee reviewed the progress that had been already achieved and drew up a comprehensive scheme for future investigations. They have recommended to the Council of Scientific and Industrial Research that a Central Plastics Research Institute at a capital cost of 20 lakhs of rupees and a recurring annual expenditure of about 4 lakhs of rupees should be established in order that long-range problems relating to this industry may be pursued in a systematic manner. They feel, however, that the subject is so vast that original investigators outside the Central Research Institute should also be encouraged to carry out laboratory experiments on these subjects, but that large-scale pilot plant experiments on the basis of the results so obtained should be carried out in co-operation with experienced workers of the Central Plastics Research Institute.

The Government of India, it is understood, have given Rs. 156 lakhs as loan and Rs. 50 lakhs as grant to the provinces to produce vegetable seeds of European variety. The target has been fixed at 41,00,000 lbs. of seeds, with a view to making India independent of imported vegetable seeds.

In the course of his presidential address at the Annual Meeting of the Indian Sugar Mills' Association, Mr. Lalchand Hirachand declared that any plan of post-war reorganisation of the sugar industry must concentrate on reduction in manufacturing costs and explore the possibility of developing the cane. He pleaded for a rational utilisation of the bye-products of the sugar industry to bring about a reduction in prices. He visualised that the output of sugar would be doubled during the post-war period.

In the course of his reply to a Civic Address presented to him by the Madras Corporation on 22nd September 1944, Dr. Ambedkar revealed that under the scheme of technical training 68,000 men had been made into skilled workmen through 300-400 training centres, spread throughout India. "It is our hope and aspiration", he said, "that the scheme of technical training, which we have built up, will not be scrapped at the end of the war, but would become a part of the educational system of this country, whereby children of the working classes, who can have no opportunity of acquiring university education and obtaining academic degrees, will have an opportunity of improving their earning capacity."

Mr. John Sargent, the Indian Educational Commissioner, has arrived at Washington after touring the United States. He has completed a study of the American University methods to see whether they are applicable to Indian schools and arrange for exchange of professors and students.

The Sugar Technologists' Association has decided to nominate Sir T. S. Venkatraman as its representative on the Indian Central Sugarcane Committee of the Imperial Council of Agricultural Research.

It is understood that the C.P. Government have decided to appoint a Committee for industrial survey in the Province. It is also understood that the Committee will be expected to make a very rapid survey of the industrial resources of the Province and consider the possibility of establishing major and minor industries and make recommendations. The personnel and terms of reference will be announced shortly.

The President of the Columbia University, Dr. Nicholas Murray Butler, announced that a two-year survey of India's post-war needs will be conducted at the University under the direction of Dr. Krishanlal Shridharani, Indian scholar and writer. Mr. Butler said: "A comprehensive survey of proposals and plans for social and national reconstruction and reforms

in India will be made in an attempt to integrate them into a comprehensive policy. The findings will be embodied in an independent non-official report on India's needs and potentialities to be published under the title "Trends of Social Thinking and Planning in India". Mr. Butler said that Dr. Shridharani has been appointed Research Associate of the Columbia University and has already begun work on the new survey. The survey was made possible by a grant of th Watumull Foundation for Indian-American relations at Los Angeles. The survey will include an analysis of contemporary social thinking in India, a critique of social, religious and educational reform groups, plans for industrial development and expansion, Lend-Lease plans affecting India and examination of American proposals with respect to post-war reconstruction and financial aid.

To bring the Travancore University Labour Corps into line with the Officers' Training Corps in other Universities, it has been reorganized and renamed the "Travancore University Officers' Training and Labour Corps".

A course of study in Military Science extending over three years has been instituted from the beginning of the current academic year. Admission to the course is open only to Cadets in the Travancore University Officers' Training and Labour Corps. The syllabi are the same as those prescribed by the Government of India for Certificates "A" and "B" Examinations in Military Science.

Mr. C. R. Srinivasan, Editor, the *Swadesamitran*, Madras, delivered a course of four lectures on "The Press and the Public", under the auspices of the University.

Sir V. T. Krishnamachariar, K.C.I.E., formerly Dewan of Baroda, will address the next Convocation of this University to be held in November 1944.

The Government of India have invited a group of Indian industrialists and businessmen to visit England and America, as soon as war exigencies permit, with the object of studying the present industrial organisation of those countries, the technical advances made by them during the last few years, and their post-war industrial plans. The Mission will be unofficial in character, and its members, all Indians of independent views and position, will be free to arrange their programme and discuss any matter, unfettered by terms of reference or any form of Government control. They will be accompanied by their own technical advisers and will bear their own expenses throughout the trip.

Government will arrange facilities for them to visit industrial establishments and to contact leaders of industry and prominent businessmen in Britain and the United States. It is believed that the Mission's study on the spot of the latest developments in the industrial sphere, and the knowledge and ideas which they will bring back wih them will be of great value in the further industrialisation of the country after the war.

The Members will not be concerned with India's Sterling balances in London, or with any specific plan of post-war economic development.

The delegation includes Messrs. J. R. D. Tata, G. D. Birla, Nalini Ranjan Sarker, Sir Padampat Singhania, Mr. Krishnaraj Thackersey, Seth Kasturbhai Lalbhai, Sir Sultan Chinoy, Mr. M. A. Ispahani, Mir Laik Ali and Mr. A. D. Shroff.

SEISMOLOGICAL NOTES

Among the earthquake shocks recorded by the seismographs in the Colaba Observatory during the month of September 1944, there were three of slight and four of moderate intensities. The details for those shocks are given in the following table:—

Date	Intensity of shock	Time of origin (I.S.T.)	Epicentral distance from Bombay	Co-ordinates of epicentre	Depth of focus
		H. M.	(Miles)		(Miles)
6	Slight	19 57	2690		
11	Moderate	16 16	3630		
14	Moderate	13 09	3110		
23	Moderate	18 43	4810		
27	Moderate	22 55	1345	Lat. 38°·0 N., Long. 81°·4 E., in Sin-Kiang, China.	
30	Slight	11 39	1395		
30	Slight	14 11	1440		

MAGNETIC NOTES

Magnetic conditions during September 1944 were slightly less disturbed than in the previous month. There were 19 *quiet* days, 10 days of *slight* disturbance and 1 day of *moderate* disturbance, as against 5 quiet days, 21 days of slight disturbance and 4 days of moderate disturbance during the same month last year.

The quietest day during the month was the 19th and the day of the largest disturbance the 30th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days	
	Slight	Moderate
1, 3, 5, 7, 9–12, 15–19, 22, 25–29	2, 4, 6, 8, 13, 14, 20, 21, 23, 24	30

No magnetic storms occurred during the months of September in the years 1943 and 1944.

The mean character figure for the month of September 1944 was 0·40 as against 0·97 for September last year.

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